FACTORS OF EFFECTIVENESS IN SCIENCE TEACHING
IN CERTAIN ATLANTA AND FULTON COUNTY
PUBLIC SECONDARY SCHOOLS

A THESIS

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DEDICATION

TO

MY MOTHER

For Her Thoughtfulness, Kindness and
Continued Inspiration, and Encouragement
through these Years.

C. F. T.

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INTRODUCTION

Rationale

There has never been greater national concern about the improvement of science teaching as there is today. Evidence that the teacher is the key to an effective science program as prompted science educators to examine the quality of the teaching-learning process in the science education program of secondary schools.

Effective science teaching is the result of planning and persistent, well-directed efforts--not a result of chance. The principles that characterize effective teaching must be understood and utilized by science teachers if our youth are to become responsible members of our democratic society.

It has long been known that the most effective learning occurs from situations in which the learner is actively engaged. This active engagement includesthe learner's understanding and acceptance of the purpose to be fulfilled.

The need for reorientation of science teaching in the high schools of America has been apparent since the late 1930's when studies revealed that the science curricular was inconsistent with new knowledge of human growth and development, incompatible with the idea of democratizing education, and at variance with the idea of promoting creativity, reflecting thinking, and problem solving among students. The early 1940's revealed that what we need is an education in science different from that ever before offered our young people. Studies showed that most traditional courses are at too great a variance with modern concepts of science and too far removed from the educational need of contemporary society to meet the demands of the period ahead.

An education that will enable young people to live intelligently in the world in which they have to live, is prevalent. What is taught must have value beyond the context in which it is learned. Learning in every course must be durable, counting for the rest of the student's life. Since much of what is educationally worthwhile has not been announced or discovered, students must be provided with an entrance into knowledge. This is to say that young people should be equipped for life-long learning and in a way that they can travel upon their own--an education that is geared to change and which trains for intellectual self-direction.

A primary objective of science education is to provide enough understanding of the place of science in society to enable the great majority that will not be actively engaged in scientific pursuits to collaborate intelligently with those who are and to be able to appreciate or criticize the effects of science on society. Science education must also provide a practical understanding of scientific methods, sufficient to be applicable to the problems which the citizen has to face in his individual and social life.

Realizing that we may not be able to agree on the desirability of a given objective in our teaching, we can at least have a good degree of accuracy measuring the outcome of learning in certain directions. Thus we may conclude that if we first state our objective we may have effective or ineffective teaching in so far as those objectives are concerned.

There is no doubt that we must focus our attention upon the critical phenomenon with which we as teachers must work--the learner. We know all too little about learning as it relates to achievement in science. Much of what is done in science classes today is based upon theories of learning that have long since been demonstrated to be untenable.

The effective science curriculum must be planned around rich experiences from selected phenomena. In the structuring of experiences we must make continual use of verbal, of real, and of mathematical models. Science mathematical models are concerned with the general inter-relationship between factors, they provide especially powerful tools for the examination of the structural and predictability of scientific concepts. Too often the purposes of instruction in science are vague or are pharased in terms of non-observable objectives and without realization of the importance of differing degrees of abstraction and anticipated pupil behavior in terms of the age, general academic achievement and career interest of the pupils.

None of the sciences can be investigated effectively without the use of information, concepts, and skills normally developed in other fields of science. Furthermore, the scientific problems which adults encounter do not come nicely labeled according to a particular science. For the education of the future laymen, as well as the fewer specialists, the present separation of the sciences according to academic fields of inquiry often present a narrow and non-usable organization. A more rewarding program might well be created by the unification of the sciences around major problems for study.

Although the idea is hacheyed it is nontheless true that an effective program depends primarily on the quality and quantity of the staff which implements it--teachers, supervisors, administrators, and special aides. A valid curriculum and adequate facilities are essential but secondary. The shortage of adequately trained teachers and other personnel needed to carry out the science program, problems related to certification and appropriate pre-service training, the proliferating demand for and changing roles of science consultants and supervisors of various levels, and the effective staff utilization must all be considered for an effective science program.

Evidence continues to indicate the need for change in emphasis during high school education. Since the early thirties, considerable time has been given to the so-called "social aspects of education" while, in the opinion of many educators, business men, and professional people, too little time has been devoted to the study of subjects in certain academic areas. Relationships between human experience and science have become so closely allied that today an educated person cannot afford to be without some knowledge and understanding of both science and humanities. To guide a change in emphasis toward such desirable ends, more emphasis should be given to the promotion of research in these fields, and to the use of findings of such research.

During the past few years, some outward signs have appeared which indicate that an improvement in quality of high school science education programs is taking place. Curriculum reorganization has shown unmistakable quickening tempo. One well-publicized effort has produced the Physical Science Study Committee's physics course (PSSC). The American Institute of Biological Sciences recently started investigation which led ultimately to new high school biology courses (BSCS); a corresponding study has been completed in chemistry (Chemistry Study and Chemical Bond). Complete courses in physics and chemistry have been filmed and are available to high schools wishing to use them. A course in classical and modern physics has been televised. The first similar course in chemistry was presented during the 1959-60 school year. The use of "open-ended" experiments and semi-micro laboratory techniques in chemistry is expanding. In the past three years many of the basic sciences have appeared in the programmed form: this form of learning has been quite popular among pre-college students. Advanced courses in science and science seminars are appearing in the curriculum of high schools. An increasing number of high school science teachers are participating in expanded in-service and institute programs designed for the improvement of subject-matter competency.

Evolution of the Problem

The writer became interested in the impact of effective science teaching and its relationship to academic success while in college. The observation of the many teaching methods after he began to teach, some effective and other ineffective, interested the writer to the extent of reviewing reports, attending conferences, and holding group discussions concerning effective science teaching. It was amazing to find that many fellow teachers of science found their teaching ineffective. This prompted the writer to do this study, with the belief that an increased knowledge of the factors involved in effective science teaching would enable him and his fellow science teachers to understand why some are effective while others are not.

Contribution to Educational Knowledge

This study was designed toreveal the professional qualifications of selected individuals teaching science in the Atlanta and Fulton County area. Similar studies might be used to ascertain the factors of effectiveness existing in any given school system. It might also indicate the effect of extra-curricular activities within or without the school, directly or indirectly, upon the teacher's effectiveness in the teaching of science. The study might provide a general picture of the physical condition affecting science teaching.

Finally, important information which the study reveals might be useful to administrators, supervisors, and teachers regarding their thoughts of strengthening and vitalizing the periodic in-service program existing in the locale studied.

Statement of the Problem

The problem of this study was to apply and evaluate the "factor of effectiveness" in the existing programs of science education in certain Atlanta and Fulton County public secondary schools.

Purpose of the Study

The major purpose of this study was to ascertain the extent of effective or ineffective science teaching in selected Atlanta and Fulton County public secondary schools. The specific purposes of this study were to answer the following questions:

1. To what extent were "factors of effectiveness" present, ignored, or otherwise neglected in the teaching of secondary school science in the schools studied?

2. What evidence existed that "factors of effectiveness" as applied to these teachers, were actually related to the overall effectiveness of these teachers?

3. What steps might be taken to increase the effectiveness of science teaching in public secondary schools of the Atlanta and Fulton County area?

Procedual Steps

The following procedual steps were executed in order to achieve the purpose of this study.

1. A further study of related literature was made.

2. Permission to conduct this study was secured from the proper authorities.

3. The questionnaires were sent to the selected persons in each school.

4. The data derived from the questionnaire and check sheet were tabulated and presented in appropriate figures, tables and/or charts.

5. The data were analyzed and interpreted in terms of the factor of effectiveness formulated by Warren M. Davis.

6. The statements of findings, conclusions, implications, and recommendations derived from the analysis and interpretation of the data were formulated in the finished thesis copy.

Description of Instruments

The instruments used in this study were derived from those formulated by W. M. Davis.[1] When necessary, his instruments were slightly changed to meet the purpose of this study and to be applied in this unique locale.

Davis utilized the method of expert opinion in developing the "factors of effectiveness." The factors were derived from his comprehensive and exhaustive survey of literature, and submission of the derived factors to a jury of experts consisting of: (a) the entire membership of the National Association for Research in Science Teaching Association; (b) a sampling of the membership of the American Association of School Administration and National Association of Secondary Schools Principals.

The seventeen factors evaluated are as follows:

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[1]Warren Maywood Davis, "Factors of Effectiveness in Science Teaching and Their Application to the Teaching of Science in Ohio's Public Secondary Schools" (unpublished Doctoral dissertation, University of Ohio, 1952).

1. Other factors being equal, effective learning is more likely to occur when the teacher has a broad background of knowledge in the particular science he is teaching as well as in the related scientific areas.

2. Other factors being equal, effective learning is more likely to occur when the teacher has a functional knowledge of how children develop and how learning takes place.

3. Other factors being equal, effective learning is more likely to occur if the teacher knows about and uses a variety of methods of instruction as opposed to the exclusive use of one or two methods.

4. Other factors being equal, effective learning is more likely to occur when the teacher is living the life of a normal citizen in the community, exerting community leadership appropriate to his educational position.

5. Other factors being equal, effective learning is more likely to occur in our society when the teacher has well-thought-out and consistent philosophy and when the teaching practice is consistent with the stated philosophy.

6. Other factors being equal, learning will proceed more effectively when the teacher is skilled in the use of classroom aids and devices, when he is familiar with, has accumulated, and uses teaching materials of various kinds, and when he knows about and uses sources of information beyond the singular textbook.

7. Other factors being equal, learning will proceed more effectively when the teacher has establsihed rapport with the learners and when the learners believe that the teacher is well informed and effective.

8. Other factors being equal, learning will proceed more effectively when the major professional interest of the teacher and his major expenditure of time and energy are concerned with teaching and not with some other occupation.

9. Other factors being equal, learning will proceed more effectively when there is mutual respect between the science teacher and his immediate supervisor.

10. Other factors being equal, learning will be more effective if the teacher is not carrying an excessive load, either by reason of an excessive number of pupils per day, or an excessive extra-curricular or out-of-school series of responsibilities.

11. Other factors being equal, learning will be more effective in a school which has a wide variety of science offerings than one which has a very limited number of such offerings.

12. Other factors being equal, more effective learning is more likely to occur when the program of the school is directed toward providing for the special needs of the youth of the community rather than when the program is not so directed.

13. Other factors being equal, more effective learning is more likely to occur when the program of the school is directed toward providing the general educational needs of youth than when the program is not so directed.

14. Other factors being equal, learning is more likely to occur when the learner and the teacher sense the direction of the teaching, when both participate in the planning, and when they see the fulfillment of their own aims implicit in the objective of the course.

15. Other factors being equal, learning is more likely to occur when the amount and type of laboratory equipment needed to fulfill the aims of the work is present and in operating condition, and if the number and type of aids, devices, supplies, and materials are at hand and in condition to be used.

16. Other factors being equal, effective learning will proceed more effectively in a good physical environment than in a poor one.

17. Other factors being equal, effective learning is more likely to occur when considerable attention is given the problem solving, development of critical thinking and scientific attitudes.

Limitation of the Study

This study was limited to the field of science teaching of selected public secondary schools of Atlanta and Fulton County. The study was further limited to a selected group of teachers of science and schools recommended and selected by the writer and his adviser. It was limited by utilization of these "factors of effectiveness" which were felt to be valid in a democratic society. Lastly, the study was limited by reliance upon "factors of effectiveness" for identification of teaching effectiveness.

Definition of Terms

For the purpose of this study, the following terms were defined:

1. "Secondary school" refers to an educational organization under one principal or head teacher, including any combination of grades from eight through twelve.

2. "Factors of effectiveness" refers to the basic set of seventeen factors derived by Warren Maywood Davis as they apply and appear to be importantly consistent with the ends of teaching in a democratic society.

3. "Converted science teacher" refers to a teacher having concentrated in a field other than science, but attempts to teach science.

Method of Research

The method of research employed in this study was the "Descriptive-Survey Method." Descriptive material was gathered by use of questionnaires and check sheets to obtain data pertinent to the study.

Locale and Period of the Study

This study was conducted during the academic year, 1964-65, inclusive of the summer of 1965. The materials were sent to twenty-five teachers of science in selected secondary schools of Atlanta and Fulton County.

Description of Subjects

The subjects involved in this study were twenty-five secondary science teachers of Atlanta and Fulton County.

Survey of Related Literature

A review of related literature bring to focus many points-of-view from eminent students and educators in the field of education. Many educators are deeply interested in the effectiveness of secondary science teachers' preparation, background, selection, and other contributing factors toward an effective and successful educational program, and thus make contributing points-of-view to this study. An effort was made to determine the extensiveness of the pertinent literature concerning the following topics:

1. Studies dealing with philosophies and objectives of science education
2. Studies dealing with science offerings in secondary schools
3. Studies dealing with the status of science teachers
4. Studies dealing with teaching effective and competence
5. Studies dealing with problems encountered by secondary science teachers
6. Studies dealing with preparation of science teachers
7. Studies dealing with facilities and equipment
8. Studies dealing with community resources.

Philosophy and objectives of science education.--Many a teacher spends his life developing and modifying his philosophies according to the changing times. There are many statements of philosophies for sound science education programs. Revelant ones have been made by those who view the public schools as institutions to perpetuate the American way of life. Among them are such persons and organizations as Dewey,[1] Bernal,[2] and the National Society for the Study of Education.[3] Analysis of these statements reveals a concensus of opinion regarding the guiding principles of a modern science education program in a democratic society. The essence of these statements is embodied in the following statement of sound science education program by Weaver:

> A philosophy is a representative of a preference for a way of life. The American way of life is that a democracy. The first concern in a democracy is for the individual's growth. . . . Our people believe that their system of free universal compulsory education will produce intelligent effective participant citizens. We must conclude therefore, that science education must also be a discipline of the individual for intelligent effective participant citizenship.[4]

The desired outcome of science teaching is dependent upon the science teacher's philosophy of science education and the development of suitable objectives from his accepted philosophy.

Edel states that a philosophy constitutes a guide to practice and every form of practice may be expressed as a philosophical outlook.[5]

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[1]John Dewey, "Methods in Science Teaching," Science Education, XXIX, No. 3 (April, 1945), pp. 119-120.

[2]J. D. Bernal, "Science Teaching in General Education," Science and Society, IV, No. 1 (Winter, 1940), p. 2.

[3]Nelson B. Henry, ed., "Science Education in American Schools," Forty-sixth Yearbook of the National Society for the Study of Education, Part I (Chicago, Illinois: University of Chicago Press, 1946) p. 39.

[4]E. K. Weaver, "A Philosophy for a Sound Education Program," Education, LXX (September, 1950), pp. 350-351.

[5]Abraham Edel, Theory and Practice of Philosophy (New York: Harcourt, Brace, & Co., 1946), p. 5.

Ragan reiterated this point when he stated that: "A teacher's philosophy is never complete--it is a living growing phenomen."[1] Whether he is aware of it or not, every decision that the teacher makes in the classroom is related to his convictions about the worth of the individual, about the nature of the good life, and about the role of the school in society; these convictions constitute his philosophy of education.

The committee for the Forty-sixth Yearbook of the National Society for the Study of Education proposed the following list of criteria for selecting objectives--criteria employed in formulating the objectives are briefly these:

1. The statement should be practical for the classroom teacher. It must be usable; when properly used, it should lead logically from one step to the next; and if carefully followed, it should result in the progress toward the objectives ultimately sought.

2. In the second place, the statement of objectives should be based on generally accepted principles of learning.

3. In the third place, the objective should be possible of attainment under reasonably favorable circumstances and to a measurable degree.

4. In the fourth place, the selected objectives should be universal in a democratic society.

5. Finally, the statement of the objectives and the explanatory context should indicate directly, or by clear implication, the relationship of classroom activity to desired changes in human behavior.[2]

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[1]William B. Ragan and Celia Burns Stendler, Modern Elementary Curriculum (2nd ed. rev., New York: Holt, Rindhart and Winston, 1961), p. 88.

[2]Henry, *op. cit.*, p. 41.

The yearbook committee conceived of objectives as directions of growth toward goals which are identifiable as changes in behavior. Not all children are expected to arrive at the same degree of attainment. The learning outcomes should be functions of changes in behavior. The report attacks the instructional approaches which produce memorization, verbalizations and mechanical skills. These were regarded as non-functionless and worthless in relation to time required to achieve them.

Several broad objectives seem to reinforce each other whereas a single narrow objective is in danger of defeating itself.

In Teaching Science in Today's Secondary Schools, it was stated:

> In the final analysis, all objectives for the science program should be determined by the need of the young people. Their needs fall into two categories (1) those that can be satisfied by acquiring information and special skills and (2) those that can be satisfied by developing certain ways of thinking and acting. The two sets of objectives operate in close conjunction with each other. Each set has its special influence upon the program. Subject matter objectives determine the content of the program. General education objectives determine what is done with the content. Neither set is effective without the other.[1]

The types of objectives proposed in the 46th Yearbook are:

1. Functional information or facts about such matters as: the universe--the earth, sun, moon, stars, weather, and climate; living things--plants and animals; the human body--its structure, function, and care; the nature of matter--elements, compounds, misture, chemical change, physical change, solids, liquids, and gases.

2. Functional concepts such as: space is bast; the earth is very old; all life evolved from simpler forms; and all matter is probably electrical in nature.

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[1]Walter A. Thurber, Teaching Science in Today's Secondary Schools (Boston: Allyn and Bacon, Inc., 1959), p. 298.

3. Functional understanding of principles, such as: all living things reproduce their kind; changes in the seasons and differences in weather and climate depend largely upon the relation of the earth to the sun; energy can be changed from one form to another; all matter is composed of single elements; and living things in a given environment or locality are mutually interdependent.

4. Instrumental skills, such as ability to: read science content with understanding and satisfaction; perform simple manipulatory activities with science; perform fundamental operations with reasonable accuracy; read maps, charts, graphs, tables, and interpret them.

5. Problem-solving skills, such as ability to: sense a problem; study the situation for all facts and clues bearing on the problem; make the best tentative explanations and hypothesis; and select the most likely hypothesis.

6. Attitudes, such as: openmindedness--willingness to consider new facts; intellectual honesty--scientific control, withholding conclusions until all available facts are in, not generalizing from insufficient data.

7. Appreciations, such as: appreciation of the contributions of scientists; appreciation of basic cause and effect relationship; sensitivity to possible ways and applications of science in personal relationships disposition to use; and scientific knowledge and abilities in such relationships.

8. Interests, such as: interest in some phrase of science as a recreational activity or hobby; interest in science as a field or vocation.[1]

The development of desirable, meaningful objectives present a colossal task for today's science teachers. The development and execution of such objectives requires persons of exceptional qualification of character and academic and professional preparation. They must be broadly educated and well versed in child development and the

[1] *Ibid.*

principles and materials of learning; for it is no longer desirable for today's youth to get the best possible training, it is imperative, if we are to survive.

The status of science education.--The first national status study in science education was carried out by Johnson in 1948-49.[1] This was followed in 1952 by Martin's[2] study of the status of high school biology. Recently, the U. S. Office of Education began writing up data obtained from a status study of secondary school science teaching. This material was issued in three bulletins.[3]

After the science teacher has formulated a point-of-view, he becomes familiar with the goals of science teaching, and familiarizes himself with the psychology of learning in the field, he must finally select and organize materials which will form the learning experience for the young people whom he will teach. The science teacher then begins to realize what Richardson meant by the statement that:

> Effective science teaching is the result of careful planning directed consciously toward objectives that are determined in the best interests of the individuals and society. Such teaching employs identifiable principles. These principles pertain to the nature of the learner and the learning process, as well as the teacher and his activity.[4]

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[1]Phillip G. Johnson, "The Teaching of Science in Public High Schools," Office of Education Bulletin, 1950, No. 9.

[2]W. Edger Martin, "The Teaching of General Biology in the Public High Schools of the U. S.," Office of Education Bulletin, 1950, No. 9.

[3]Ellsworth S. Obourn, "Surveys and Status Studies," Science Education, XLV (December, 1961), No. 5, pp. 391-393.

[4]John S. Richardson, Science Teaching in Secondary Schools (Englewood Cliffs, New Jersey: Prentice-Hall, 1959), p. 34.

Today, the secondary school is gradually attempting to formulate its program to meet the needs of the youth who attends it. While preparation for college is recognized as one of the needs of a relatively small group, the nature and method of school experience, as well as its evaluation, are evolving in many well-planned schools in such ways that all may benefit. The following statement of the National Education Association summarizes this point of view:

> Schools should be dedicated to the propostion that every youth in these United States--regardless of sex, economic status, geographic location, or race--should experience a broad and balanced education which will (1) equip him to enter an occupation suited to his abilities and offering reasonable opportunity for personal growth and social usefulness; (2) prepare him to assume the full responsibilities of American citizenship; (3) give him a fair chance to exercise his rights to the pursuit of happiness; (4) stimulate intellectual curiosity, engender satisfaction in intellectual achievement, and cultivate the ability to think rationally; and (5) help him to develop an appreciation of the ethical values which should undergird all life in a democratic society.[1]

Crowder[2] found that teachers felt that they were in a sense second class members of the community, fooling themselves and restricted often at the expense of their creativity. However, Mead[3] and Kaplan[4] believed

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[1] Educational Policies Commission, "Education for All American Youth," NEA Journal (Washington, D. C., 1944).

[2] Farnsworth Crowder, "Educational Strait Jackets," Survey Graphic, XXXVI (November, 1947), pp. 617-619.

[3] Margaret Mead, "Teachers Place in American Society," American Association of University Women's Journal, XXI (October, 1946), pp. 3-5.

[4] Louis Kaplan, "New Horizons in Teacher-Community Relationship," Journal of Educational Society, XXI (March, 1948), pp. 417-427.

that the situation described by Crowder is being changed somewhat. Therefore, a portion of this present study is directed toward what Atlanta and Fulton County teachers think of their own status in the community.

In a very searching inquiry in extra-contractual income of Wisconsin teachers, Stuart Anderson found that 60 per cent of Wisconsin respondents have some extra-contractual income, most of them earned at least a part of this money while teaching. Anderson recommended that "teachers should periodically engage in suitable work experiences, on a voluntary basis, at an occupation other than teaching, in order that they may gain a better understanding of the community and its economic life."[1]

Another group has expressed this point of view by the statement: "The purpose of general education is to meet the needs of individuals in the basic aspects of living in such a way as to promote the fullest possible realization of personal potentialities and the most effective participation in a democratic society."[2]

A simular statement has recently been phrased thusly: "The purpose of the school is to provide the best possible conditions for the

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[1]Stuart Anderson, "A Study of the Professional Personnel of Wisconsin Schools with Special Reference to Extra-Contractual Income," Journal of Experimental Education, VIII (September, 1948), pp. 92-200.

[2]Commission of Secondary School Curriculum Progressive Education Association, Science in General Education (New York: Appleton-Century Crafts, Inc., 1938).

students' steady and harmonious growth both toward his own individuality and toward his more responsible membership in a democratic society."[1]

In a review of related problems in science, H. H. Giles stated that:

> Any program for science in the secondary school planned for achieving the purposes of general education is concerned with four interrelated problems: the goals or objectives to be met, the content or subject matter to be included, the experiences to be provided or the methods to be used, and the evaluation procedures to be utilized in determining the extent to which progress has been made toward achieving the objectives. These are very closely interrelated and are not separate categories. The content, or subject matter, as well as the method used, should be suggested by and consistent with the objectives. The evaluation should be concerned with the objectives sought and the procedures used.[2]

Science offerings in secondary schools.--The problem of providing adequate science electives is made difficult by pressures for teacher time and for laboratory space. Many small schools are just barely able to maintain the three major electives by alternating them with each other or with other subjects. Experimentation with additional electives has been done generally in larger schools.

Johnson, in a survey of 735 schools, found a number of them offering courses in applied physics, applied chemistry, and applied science.[3] These courses are usually less rigorous then the academic

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[1]Miami Workshop Committee, Working Together for Ohio's Schools (Kent, Ohio: College of Education, Kent State University, Second Miami Workshop).

[2]H. H. Giles, S. P. McCutchen, and A. N. Zechiel, Exploring the Curriculum (New York: Harper, 1942), p. 2.

[3]Johnson, op. cit., No. 5.

courses they parallel. Physical science is ocasionally offered as a substitute for physics and chemistry. It shows promise of making important contributions but is not attracting any great enrollment as yet.

In the last decade or two, high schools have increasingly offered additional science courses. Brown stated that:

> In a study of the United States Office of Education published in 1950, a report was made of these offerings from a sample of 715 high schools over the United States. Of the 715 reporting schools, 135 or about 19 per cent reported additional or alternate science courses. Sixty-one schools included physical science courses of one kind or another. Chemistry and physics often included materials from meteorology, astronomy, and geology. Forty-nine schools offered broad science courses. The most common additional or alternate offering could best be described as an "applied-science" course. In addition, offerings included specific courses in physiology, earth science, electricity and radio, science of aviation, and photography.[1]

The basic science courses taught in secondary schools from 1890-1956 as illustrated by Brown follows:

PERCENTAGE OF PUPILS ENROLLED IN PUBLIC HIGH SCHOOL WHO WERE ENROLLED IN SCIENCE COURSES[2]

Year	Gen. Sc.	Biology	Chemistry	Physics
1890	-	-	10.1	22.8
1900	-	-	7.7	19.0
1910	-	1.1	6.9	14.6
1915	-	6.9	7.4	14.2
1922	18.3	8.8	7.4	8.9
1928	17.5	13.6	7.1	6.8
1934	17.8	14.6	7.6	6.3
1949	20.8	18.4	7.6	5.4
1956	21.8	20.5	7.5	5.4

[1]Kenneth E. Brown, _Offerings and Enrollment in Science and Mathematics in Public High Schools, U. S. Department of Education_, No. 120 (Washington, D. C.: U. S. Government Printing Office, 1957).

[2]_Ibid._

Teaching effectiveness and competence.--Although most educators agree that the science teacher should be capable of using several methods of teaching science and of applying them where they are most effective, many science teachers still argue the use of the lecture-demonstration method as compared to the individual laboratory method in terms of superiority. Cunningham analyzed thirteen articles, six doctoral thesis and eight master's thesis pertaining to the problem of lecture-demonstration versus individual laboratory methods of teaching science.[1] The report indicated that the data did not conclusively favor one of the two methods. The method selected for a given course is determined by the conditions under which the course is taught and by the objectives of the course. In comparing the effectiveness of a lecture method with a small group discussion method of teaching high school biology, Taylor wrote: "Since there doesn't seem to be any best method of teaching, as evident by other studies, teachers should for the present, use that method which is most convenient and satisying."[2]

Ingram[3] was in consonance with Johnson[4] in the statement that certain of the causes noted by the administrators and the teachers

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[1]Harry A. Cunningham, "Lecture-Demonstration Versus Individual Laboratory Method in Science Teaching--A Summary," Science Education, XXX (March, 1964), pp. 70-82.

[2]Harold O. Taylor, "A Comparison of the Effectiveness of A Lecture Method and A Small Group Discussion Method of Teaching High School Biology," Science Education, XLIV (December, 1959), pp. 442-446.

[3]Silas Ingram, "Factors of Effectiveness in Science Teaching in Certain of the Richmond County Public Schools" (unpublished Master's thesis, School of Education, Atlanta University, 1963).

[4]Robert S. Johnson, "Factors of Effectiveness in Science Teaching in Georgia Public Secondary Schools Accrediated by the Southern Association of Colleges and Secondary Schools" (unpublished Master's thesis, School of Education, Atlanta University, 1960).

involve the preparation period of the prospective teachers. If a teacher fails or is incompetent because he does not know how to conduct a class, then the teacher training institution must bear much of the blame. Conversely, if the lack of these abilities cause failure of the teacher it may be safely assumed their possession in a higher degree would render a teacher more effective.

In comparison with the above material, Nathan S. Washton stated that:

> It would be unfortunate if a science teacher tried one of the proposed methods and, finding such a method adequate, abandon it promptly. A given method or approach to teaching science needs to be refined for each teacher and each class. It may take many trial-and-error experiences before the science teacher masters a specific technique or approach to teaching a given topic or problem in science. This is especially true if he attempst to use the problem-solving method. It is also possible that a particular approach is more effective for some individuals and classes than others. Hence, the science teacher should "experiment" with his methods of teaching. It should be remembered that patience in trying out new techniques is a basic requirement of the scientist as well as the educator.[1]

Effective teaching is based upon a clear understanding of the "developmental tasks" of children. Havighurst states that the tasks which the individual must learn is the developmental task of life--these things which constitute healthy and satisfactory growth in our society. They are the things a person must learn if he is to be judged and to judge himself to be a reasonably happy and successful person.[2]

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[1]Nathan S. Washton, Science Teaching in Secondary Schools (New York: Harper, 1961), p. 14.

[2]Robert J. Havighurst, Developmental Tasks and Education (New York: Lognmans, Green, 1950), pp. 4-6.

Recent social-psychology research provide us with an abundance of information as to how we can improve classroom learning situations as well as human relations.[1]

In our survey we could not overlook the problem of discipline. In relation to discipline, Edwin Swineford stated that the relationship between the competence of the teacher and the kind of discipline trouble spots he encounters, showed, through a rating scale, that the lower the rating of teaching efficiency of the teacher, the higher the number of incidents of discipline reported in each category.[2]

Street felt that competencies cannot be described in terms of lists of desirable teachers' traits.[3] He felt that any listed traits are meaningless until they become part of an individual's pattern of behavior. Further, he saw, competencies described as a pattern, or constellation of interacting factors. Arranged around this were skills, attitudes, knowledges, methods, and understandings, tools and purposes, and "know-how."

Preparation of science teachers.--The preparation of the teachers previous to entering his profession, should be such that he meets the

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[1]W. W. Charters, Jr., "Human Relation in Education," Review of Educational Research, XXIX (October, 1959), pp. 313-390.

[2]Edwin Swinford, "Discipline: A Basic Problem of Beginning Teachers," Clearing House, XXXVI (February, 1962), pp. 350-352.

[3]Calvin M. Street, "The Development of a Competent Pattern with Application to the Area of Industrial Arts Education" (unpublished Doctorial dissertation, University of Tennessee, 1953).

generally recommended preparation for certification.[1] The State of California is to be congratulated for its step in going well beyond these minimum standards.[2]

Today's increased interest for more rigorous preparation of science teachers stems from several causes: (1) the rapid developments of this dynamic, constantly evolving discipline; (2) the increasing complexities in scientific theory; and (3) the importance of achieving in the near future a public that is scientifically literate.

In an attempt to discover the elements of teacher's skills, and things basic to the art of teaching, Robert MacCurdy asked deans, directors and principals these questions in 106 universities and colleges, and technical schools. This is what they said:

1. They need a knowledge of the nature, purpose, and administrative organization of higher education.

2. They need a knowledge of the psychology of youth and preparation of counseling.

3. They need a knowledge of educational psychology, the principles of learning, the art of teaching, of method and of tests and measurements.

4. They need an apprentice training or internship.[3]

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[1] The AAAS Cooperative Committee on the Teaching of Science and Mathematics, "Recommendations for the Training of Science Teachers," School Science and Mathematics, CXXXI, No. 3406 (April 8, 1960).

[2] Chemical and Engineering News (July 3, 1961), p. 25.

[3] Robert MacCurdy, "Call Him Teacher," Science Education, LXIX, No. 1 (February, 1963), p. 28.

Bryant stated that an examination of the curriculum for prospective teachers in four undergraduate institutions attended by the subject of her study, indicated that there were few provisions for them to have adequate preparation in the areas which could be categorized as concerned with modern approaches to growth and development, although "traditional" courses in educational and adolescent psychology are offered.[1]

Facilities and equipment.--Another factor in the quality of instruction in science is the role played by facilities and equipment. Since investigation results are available on facilities and equipment needed in science teaching, a study of these results should enable us to determine what facilities and equipments are needed for bring our science teaching up to adequate standards.

The National Defense Education Act, signed by former President Eisenhower on September 2, 1958, has made millions of dollars available for the remodeling of science classrooms and for the purchase of equipment, audio-visual aids and printed materials other than textbooks. Before these funds were made available, Charles Koelsche reported that the overall rating of science equipment showed that chemistry equipment was judged best, general science second, biology third, and physics poorest.[2]

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[1]Vera R. Bryant, "The Effectiveness of Science Teaching in Certain Atlanta Public Elementary Schools" (unpublished Master's thesis, School of Education, Atlanta University, 1958), p. 38.

[2]Charles L. Koelsche and John S. Richardson, "Facilities and Equipment Available for Teaching Science in Public High School, 1958-59," Research Foundation, University of Toledo, 1960, pp. 27-33.

For some science teachers adequate equipment would consist primarily of those materials specified by the textbook and/or laboratory manual. For others, equipment and supplies that would open the doors of science through student exploration and self-discovery would be considered essential. The teacher's philosophy of science teaching, methods and techniques used, and the learning acrivities included in the program must be considered in determing the types and amounts of equipment to be made available.

Science facilities in the past have reflected the influence of programs andfacilities in many schools. Recent changes in the science program brought about the various curriculum planning committees (PSSC, CBA, CHEM Study, and BSCS) revealed a need for a critical evolution of existing science facilities. Thomas Francis concurred with this thought when he stated that an important improvememt in the science program is brought about by the new involvement of highly specialized equipment.[1]

The type of facilities needed should be determined by the objectives of the program, kinds of learning activities to be included in the program, and the nature of the content and its organization. Two extreme positions are in evidence. On the one hand, some teachers believe that teaching of science is at its best when a good textbook, along with its laboratory manual is used. This is usually done without

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[1]Thomas Francis, Summary of Current Science Improvements," Science Newsletter, XXXVI (July, 1963), p. 21.

audio-visual aids. With reference to the use of audio-visual aid, Nelson and Kelly stated that if the science program does not use audio-visual material, the teacher is probably working too hard. By the same token, many teachers have discovered that audio-visual resources are not the panacea for the challenge of hard work which characterize all education. The truth of the matter is, that if audio-visual materials are being used, the teacher is accomplishing proportionately more.[1]

At the other extreme are teachers who believe that in teaching science emphasis should be placed on the process of science as well as the product. The science classroom should be designed to open the doors of science to the student by providing opportunities for exploration and self-discovery. The desigm of the science facilities to provide this type of learning experience would include flexibility of furniture and equipment, space requirement for individual and group activities, and provision for the use of many teaching methods and materials. Regardless of the position taken, the science program must be designed to meet the need of the students of that community.

Regardless of the extent of equipment and facilities, the teacher is the primary source of learning, as was so brillantly stated by Charles Todd when he said that the teaching staff of an educational institution is its most essential item of equipment. Providing suitable

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[1]Pearl A. Nelson and Gaylen B. Kelly, "Some Common Problems in the Use of Audio-Visual Materials," Science Education, XLVIII, No. 1 (February, 1964), p. 37.

teachers for American schools is a task so colossal that our civilization is staggered in its effort to meet the demands.[1]

Facilities are means to ends; this principle is exiomatic. Yet it seems entirely appropriate to emphasize it in this particular instance. All equipment and facilities are provided to improve the material aspect of the instructional process. The best facilities are to no avail in the absence of a dynamic and creative teacher.

Community resources.--The place and importance of community resources in science teaching has long been a concern of science educators. There has not been a complete agreement among administrators and science teachers as to the real contribution they make to the total science program. Effective use of community resources requires that the teacher survey and evaluate the local community listing the resources that contribute most to an understanding of the specific science area under study.

Some science teachers contend that, of the various types of instructional materials available, community resources are the most important. Other science teachers contend, along with some administrators, that the use of community resources is too time consuming, and makes little, if any, real contribution to the science program. Usually the resources are not closely related to the materials found in the textbook and the laboratory manual thus making it difficult to justify their use.

It is Thurber's contention that: There are some surperb teaching situations around most schools. For one school it may be a pond. For

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[1] Charles H. Todd, "The Teacher," Phi Delta Kappan Bulletin, XXII (Chicago, 1960, p. 78.

another it may be a bakery. For still another it may be a museum. These resources should not be neglected. Trips taken within the confines of the school property present few administrative problems. Most school systems permit teachers to take their pupils anywhere within these limites without special permission.[1]

Science teachers should re-evaluate their position regarding the use of community resources in science teaching. Do community resources contribute to effective science teaching? What kinds of resources should be used? To what extent should the school be community centered? These are some questions which the science teacher must answer in order to determine the extent to which the community's resources are to be utilized.

Problems encountered by science teachers.--The task that confronts a teacher is one of high complexity and one which carries with it the deepest obligation. It is a task unequaled in any other profession for the need of deep understanding and fineness of skills. Many educators have found numerous reasons for the effectiveness or ineffectiveness of the science teacher.

In order to determine the problems of teachers of science and mathematics now operating to reduce their teaching ineffectiveness, a questionnaire was printed in an issue of School Science and Mathematics. Replies from 326 teachers, working grades 7-12 indicated that: (1) teachers lack laboratories, (2) teachers lack equipment and supplies,

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[1]Thurber, op. cit., p. 390.

(3) teachers lack classrooms especially adapted for science teaching, (4) teachers lack a room that a science teacher could call his own, (5) teachers lack time for preparing materials for laboratory and classroom demonstrations, (6) teachers lack reference materials, books, and periodicals, (7) teachers have classes ranging from 30-40, (8) teachers have too many extra-curricular duties, (9) teachers must do extra jobs to supplement income, (10) teachers have two many preparations per day, and (11) teachers have too many classes per week.[1]

A survey of many teaching programs showed that part of the teacher's day is spent in completing routine clerical tasks. Koelsche stated that:

> If science teachers are going to be effective in bring about an improvement in science education in the high schools, they must be allotted special time for doing some of the added duties associated with their positions. These duties involve keeping up-to-date inventory of science equipment and supplies--setting up for demonstration and laboratory work; and maintenance of equipment. A portion of the needed time could be obtained by eliminating all duties unrelated to s cience teaching from the assignment of science teachers.[2]

The investigation pointed out that, occasionally, class presentations are of less than professional standard because of the lack of preparation time. This leads us to the hypothesis that some tasks now done by the professional teacher could be done by less trained personnel, resulting in an up-grading of the teacher's presentation.

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[1]Kenneth E. Anderson, "The Relationship Between Teachers' Load and Student Achievement," School Science and Mathematics, L (June, 1950), pp. 468-470.

[2]Charles L. Koelsche, "Facilities and Equipment Available for Teaching Science in Public High Schools, 1958-59," Science Education, XLV, No. 4 (October, 1961), pp. 465-472.

The use of "converted" science teachers has resulted in problem teachers. In a 1960 publication it was stated that: (1) ten per cent of the "converted" teachers had taken no courses in science and 25 per cent had taken just one or two semesters of any science, (2) the "converted" science teacher did not use varied and effective instructional practices as often as the qualified science teacher, and (3) the "converted" science teacher ranked methods of science teaching first in important help needed, while the qualified science teacher considered help in planning and organizing class work most important.[1]

The science teacher is vitally concerned with all these problems. In the actual day-to-day work with students, however, certain problems recur: What experiences can and should be provided? What activities are most appropriate to achieve the purposes which have been agreed upon? These are problems of method, of procedure of planning and organizing student activities. What are the students to do, and what does the teacher do to encourage and guide these experiences adequately?

Summary of the review of related literature.--Many points-of-view from eminent students and educators in the field of education are brought to focus in this study of related literature. However, the literature pertinent to this study was organized under the captions as follows: (1) Studies Dealing with Philosophies and Objectives of Science Education (2) Studies Dealing with the Status of Science Education (3) Studies Dealing with Science Offerings in Secondary Schools

[1]United States Office of Education, Nos. 1-5 (Washington: U. S. Government Printing Office).

(4) Studies Dealing with Teaching Effective and Competence (5) Studies Dealing with Preparation of Science Teachers (6) Studies Dealing with Problems Encountered by Secondary Science Teachers (7) Studies Dealing with Facilities and Equipment (8) Studies Dealing with Community Resources.

A review of related literature has made possible the following generalizations:

1. Science educators who view public schools as institutions to perpetuate the American way of life agree that a sound science education program in America should be guided by a democratic philosophy. The objective should be: (a) to provide enough understanding of the place of science in society to enable the great majority that will not be actively engaged in scientific pursuits to collaborate intelligently with those who are not and (b) to give a practical understanding of scientific method, sufficient to be applicable to the problems which the citizen has to face in his individual and social life.

2. Secondary school science should be taught in terms of major concepts of science. Emphasis should be placed on the development of instrumental skills, skills in the use of the scientific attitudes and development of functional understanding of scientific information.

3. The secondary school should provide more preparation time for the science teachers by limiting of the number of classes per day and deleting many of the tasks which may be done by less trained personnel.

4. The curriculum should be flexible and suited to the end of the learner and the community. There should be a gradual sequence of science.

5. A good teacher is regarded as one possessing a pleasing personality, understanding of the pitfalls and stumbling blocks in the learning process, depth and breath of science understanding, skills, attitudes and a variety of methods and techniques and a functional understanding of child development and psychology.

6. Teacher-pupil planning can be very effective. There is a significant relationship between teacher adjustment and pupil adjustment and between their efficiency.

7. The present programs of pre-professional, and professional training leave much to be desired.

CHAPTER II

ANALYSIS AND INTERPRETATION OF DATA

This chapter presents an analysis and interpretation of the data obtained through the administration of the questionnaire and checksheet.

The data of this study is organized under six different headings.

Part I. Reactions of the respondents to the factors of effectiveness

Part II. Personal characteristics of the respondents

Part III. Professional characteristics of the respondents

Part IV. Reactions of the respondents to questions pertaining to methods and materials of instruction

Part V. Reactions of the respondents to questions pertaining to facilities necessary for effective science teaching

Part VI. Reactions of the respondents to questions pertaining to provisions made for students with special aptitudes or interest in science.

Respondents' Reaction to the Factors of Effectiveness

The data on the extent of agreement and disagreement with reference to the seventeen "factors of effectiveness" as indicated by the twenty-five secondary science teachers was organized into nineteen tables. This data is found in Tables 1-19.

The respondents' reaction to the seventeen factors of effectiveness is presented in Tables 1-19, with the appropriate table accompanying each factor analysis.

Factor 1.--Other factors being equal, effective learning is more likely to occur when the teacher has a broad background of knowledge in science as well as in related scientific areas.

TABLE 1

Item	Number of Responses	Percentage
Agreement	24	96
Qualified agreement	1	4
Disagreement	0	0
Qualified disagreement	0	0
Total	25	100

Twenty-four or 96 per cent of the respondents agreed with this factor. One or 4 per cent qualified their agreement, however, none of the respondents disagreed. Agreement with this factor meant that the teacher would recognize the need for a broad background of knowledge in the area of the humanities, the social sciences, esthetics, mathematics, growth and development, the learning process, curricular and society and similar areas. Further, the teacher would use this broad general educational background in the teaching of science at the secondary school level. Examination of respondents' preparation indicated that some effort has been made toward developing a broad background of knowledge in science.

Factor 2.--Other factors being equal, effective learning is more likely to occur when the teacher has a functional knowledge of how children develop and how learning takes place.

TABLE 2

Item	Number of Responses	Percentage
Agreement	24	96
Qualified agreement	1	4
Disagreement	0	0
Qualified disagreement	0	0
Total	25	100

Agreement with this factor means that the teacher would need a working knowledge of growth and development, educational psychology and child psychology. This factor ranked two in acceptance. Twenty-four or 96 per cent of the respondents agreed with this factor. This indicated that the respondents realized the fact that a knowledge of growth and development facilitates effective teaching.

Factor 3.--Other factors being equal, effective learning is more likely to occur when the teacher knows about, understands and uses a variety of methods of instruction as opposed to the exclusive use of one or two methods.

TABLE 3

Item	Number of Responses	Percentage
Agreement	22	88
Qualified agreement	2	8
Disagreement	0	0
Qualified disagreement	1	4
Total	25	100

There have been any number of approaches to the selection of method or methods of teaching. However, a recent trend has been to regard the problem of methodology in a fluid manner, and as an attempt to apply what we know about the learning process, growth and development, and the needs and interests of children, to the teaching-learning situation. In this regard there has emerged a concept of method or methods involving the use of whatever effective technique, group process, and the like as is seen to be most appropriate in a teaching-learning situation. This means that the competent teacher, from this point of view, should know, understand, and utilize a variety of methods and that no one method can be utilized to the exclusion of another. Twenty-two or 88 per cent of the respondents agreed with this factor, ranking it four. Because of high percentage of agreement with this factor, it can be said that these teachers are conversant with the literature which supports their position and that these teachers are operating in fluid manner employing the use of a variety of methods. The literature, within recent years, is replete with admonitions against the use of one or two methods of teaching as inadequate for the attainment of goals of modern education programs. It is encouraging to note that a significant number of these teachers have pursued courses in education beyond the Bachelor's degree. Therefore, we may conclude that these teachers have recognized the need to improve their teaching methods and seek means of doing so.

Factor 4.--Other factors being equal, effective learning is more likely to occur when the teacher is living the life of a normal citizen of the community, exerting community leadership appropriate to his educational pattern.

TABLE 4

Item	Number of Responses	Percentage
Agreement	17	68
Qualified agreement	2	8
Disagreement	4	16
Qualified disagreement	2	8
Total	25	100

Seventeen or 68 per cent of the respondents agreed with this factor; four or 16 per cent disagreed. The contention was that leadership and participation in community activities added to the already over-loaded duties of the teachers. It is interesting to note that fourteen or 56 per cent of the respondents held no position as leaders in community organizations. Children observe their teachers not participating in organizations which play significant roles in community life. This being so, they cannot be expected to "learn" to be effective citizens from these teachers. Agreement with this factor means that by virtue of his position, the teacher is given the role of a leader whether he fulfills it or not and that, as far as possible, he is expected to lead the kind of community life that cocuments the every day applications, as a functioning citizen, about which he teaches the children. This factor received rank eight.

Factor 5.--Other factors being equal, effective learning is more likely to occur in our society when the teacher has a well-thought-out philosophy and when his teaching practice is consistent with the stated philosophy.

TABLE 5

Item	Number of Responses	Percentage
Agreement	22	88
Qualified agreement	2	8
Disagreement	0	0
Qualified disagreement	1	4
Total	25	100

This factor received rank four with 88 per cent accepting it. Four per cent qualified disagreement with this factor on the basis that a teacher teaches what he is assigned or a given theory regardless of his beliefs. This percentage of the respondents tend to have a pessimistic approach and a laissez faire attitude toward the teaching of science.

Factor 6.--Other factors being equal, learning will proceed more effectively when the teacher is skilled in the use of classroom aids and devices, when he is familiar with, has accumulated, and uses teaching materials of various kinds, and when he knows about and uses sources of information beyond the singular textbook.

TABLE 6

Item	Number of Responses	Percentage
Agreement	25	100
Qualified agreement	0	0

TABLE 6--Continued

Item	Number of Responses	Percentage
Disagreement	0	0
Qualified disagreement	0	0
Total	25	100

This factor received twenty-five or 100 per cent agreement. The respondents' complete agreement indicated that all of them were familiar with resources for science teachers, with the operation of audio-visual devices and had a great dependence upon two, three or more textbooks. The agreement with this factor meant that the teacher should have an accumulation of skills in the use of film projectors, slide projectors, films and other similar aids and devices, as well as many sources of references. This factor ranked one.

Factor 7.--Other factors being equal, learning will proceed more effectively when the teacher has established rapport with the learners and when the learners believe that the teacher is well informed and effective.

TABLE 7

Item	Number of Responses	Percentage
Agreement	24	96
Qualified agreement	1	4
Disagreement	0	0
Qualified disagreement	0	0
Total	25	100

This factor has twenty-four or 96 per cent agreement. Agreement with this factor implied acceptance of the point of view that one of the tasks of the teacher is to establish a relationship with pupils of such a nature as to cause them to share, think and cooperatively plan their program with the teacher. Such rapport can often be established through theteachers' knowledge of the basic needs of children, understanding of their growth and development and through the utilization of whatever competencies the teacher has to create a situation, and to provide such opportunities, that the learner will increasingly identify themselves with the learning process. This factor ranked two.

This means that the teacher will use whatever background of knowledge he possesses in order to establish the necessary relationship with students. These respondents indicated that they considered such a relationship to be important in successful teaching.

Factor 8.--Other factors being equal, learning will proceed more effectively when the major professional interest of the teacher and his major expenditures of time and energy are concerned with teaching and not with some other occupation.

TABLE 8

Item	Number of Responses	Percentage
Agreement	21	84
Qualified agreement	2	8
Disagreement	1	4
Qualified disagreement	1	4
Total	25	100

Twenty-one or 84 per cent of the respondents agreed; two or 8 per cent qualified agreement. Agreement with this factor means a recognition of the fact that a mind relaxed and unencumbered with economic worries, a well rested body and sufficient time to carefully plan the school's days activities are necessary for effective teaching. One of the respondents completely disagreed that there is considerable relationship between teaching effectiveness and engagement in work other than teaching. However, one or 4 per cent qualified his disagreement. This factor ranked five.

Factor 9.--Other factors being equal, learning will proceed more effectively when there is mutual respect between the science teacher and his immediate supervisor.

TABLE 9

Item	Number of Responses	Percentage
Agreement	20	80
Qualified agreement	2	8
Disagreement	2	8
Qualified disagreement	1	4
Total	25	100

Twenty or 80 per cent of the respondents agreed to this factor which meant that a relationship free from bias, strife and tension would enhance a teacher's effectiveness and thereby percipitate effective learning. Two or 8 per cent of the respondents completely disagreed while one or 4 per cent qualified his disagreement. This factor ranked six.

Factor 10.--Other factors being equal, learning will be more effective if the teacher is not carrying an excessive load, either by reason of an excessive number of pupils per day, or an excessive extra-curricular or out-of-school series of responsibilities.

TABLE 10

Item	Number of Responses	Percentage
Agreement	25	100
Qualified agreement	0	0
Disagreement	0	0
Qualified disagreement	0	0
Total	25	100

Twenty-five or 100 per cent of the respondents agreed with this factor without any qualification. Complete agreement meant that all of the respondents realized that teaching effectiveness is decreased when the teacher is overloaded. Excessive preparations mean that no other preparation can receive the time and thought needed to make it approach perfection. An excessive extra-curricular or out-of-school series of responsibilities would be too demanding upon the teacher's time and energy and would lower his performance. None of the respondents disagreed with this factor. This factor ranked one.

Factor 11.--Other factors being equal, learning will be more effective in a school which has a wide variety of science offerings than one of which has a very limited number of such offerings.

TABLE 11

Item	Number of Responses	Percentage
Agreement	20	80
Qualified agreement	3	12
Disagreement	1	4
Qualified disagreement	1	4
Total	25	100

Twenty or 80 per cent of the respondents completely agreed that the more experience the pupil has the greater his chances were of grasping and retaining fundamental and specific knowledge. Three or 12 per cent of the respondents qualified their agreement. Agreement with this factor meant that the teacher should have a knowledge of how learning takes place and the theories of learning and that such a program would widen the life spand of the child. The teacher should be allowed to take an active part in planning the school's curriculum and he should be able to employ vicarious experiences that are meaningful and applicable to a particular situation. A good teacher endeavors to enlarge the pupil's area of experience and checks against some frame of reference. It is necessary, however, that the entire staff, who will guide the development of any pupil over the school period work out a frame of reference together to provide for continuity and inclusiveness. This factor received one or 4 per cent complete disagreement and one or 4 per cent qualified disagreement; giving it a rank of six.

<u>Factor 12</u>.--Other factors being equal, more effective learning is more likely to occur when the program of the school is directed toward providing for the special needs of youths than when the program is not so directed.

TABLE 12

Item	Number of Responses	Percentage
Agreement	21	84
Qualified agreement	1	4
Disagreement	2	8
Qualified disagreement	1	4
Total	25	100

Twenty-one or 84 per cent of the respondents agreed to this factor and one or 4 per cent qualified his agreement. Agreement with this factor meant that careful study should be made of the pupil and the community to determine the present needs of the pupils and what might be their future needs. To do this effectively, the teacher must be aware of the trends in the community, pupils, inference and should be directly associated with the community through active participation. The teacher is a part of the school. The school serves as the community instrument through which the conditions essential for a more adequate life are progressively achieved. In order to discern and meet these individual needs, a knowledge of child growth and development is necessary. A knowledge of the social sciences is necessary to determine and help meet the present and future needs of the child and to help prepare him for intelligent forward adjustment. One or 4 per cent disagreed and two or 8 per cent qualified their disagreement. This factor ranked four.

Factor 13.--Other factors being equal, more effective learning is more likely to occur when the program of the school is directed toward providing the general educational needs of youths then when the program is not so directed.

TABLE 13

Item	Number of Responses	Percentage
Agreement	17	68
Qualified agreement	3	12
Disagreement	1	4
Qualified disagreement	2	8
Total	25	100

Seventeen or 68 per cent of the respondents agreed and three or 12 per cent qualified their agreement to this factor, while four or 16 per cent disagreed. This agreement meant that the major objectives of the school's program goes beyond the development of knowledge and skills to encompass the needs of the child in relation to the community. The present trend is to base the program so as to equip the child to meet, in a desirable manner, situations growing out of his environment; this factor ranked seven. It was surprising that this factor ranked so low.

Factor 14.--Other factors being equal, learning is more likely to occur when the learner and the teacher sense the direction of the teaching, when both participate in the planning, and when they see the fulfillment of their own aims implicit in the objective of the course.

TABLE 14

Item	Number of Responses	Percentage
Agreement	21	84
Qualified agreement	3	12
Disagreement	0	0
Qualified disagreement	1	4
Total	25	100

Twenty-one or 84 per cent of the respondents accepted this factor, one or 4 per cent qualified his disagreement. The agreement to this factor meant that pupils and teachers have recognized a problem, a problem of interest and need and one which can be solved. Further, teachers and pupils have formulated objectives and have arrived at methods and procedures for attaining these objectives. This is so organized that the pupils have full benefit of observation and participation. The pupil must have an extensive knowledge of planning and how to encourage pupils. The teacher-pupil cooperation must be actively engaged in and pupils must share in the making of decisions. It is, therefore, necessary that teachers have developed adequate concepts of child growth and development and an understanding of children, their needs and interests. This factor ranked five.

Factor 15.--Other factors being equal, learning is more likely to occur when the amount and type of laboratory euipment needed to fulfill the aims of the work is present and in operating condition, and if the number and type of aids, devices, supplies, and materials are at hand and in condition to be used.

TABLE 15

Item	Number of Responses	Percentage
Agreement	23	92
Qualified agreement	2	8
Disagreement	0	0
Qualified disagreement	0	0
Total	25	100

Twenty-three or 92 per cent of the respondens completely agreed with this factor. Agreement with this factor meant that the teacher must first know the amount and type of materials needed to fulfill the aims of the work. He must see, as far as possible, that they are available. He must have a knowledge of the most effective ways of using these materials and supplies. He must have an operative knowledge and be ableto make minor adjustments if and when needed. Respondent's statements indicated that ample laboratory equipment and materials were available for effective science teaching.

None of the respondents disagreed with this factor, ranking it three.

Factor 16.--Other factors being equal, learning will proceed more effectively in a good physical environment than in a poor one.

TABLE 16

Item	Number of Responses	Percentage
Agreement	25	100
Qualified agreement	0	0
Disagreement	0	0
Qualified disagreement	0	0
Total	25	100

Twenty-five or 100 per cent of the respondents agreed that learning will proceed more effectively in a good physical environment than in a poor one. None of the respondents qualified their agreement to this factor. This factor ranked one. Agreement with this factor meant recognition of the fact that one's surroundings have an immense influence upon personal behavior. A room that is cleaned, well painted, attractive, sufficiently large enough to accommodate the class without crowding, one that has the work and display area, proper heating, lighting and ventilation encourages pleasantness and receptive minds.

Factor 17.--Other factors being equal, learning will be more effective when considerable attention is given to problem solving, development of critical thinking and scientific attitudes.

TABLE 17

Item	Number of Responses	Percentage
Agreement	21	84
Qualified agreement	2	8

TABLE 17--Continued

Item	Number of Responses	Percentage
Diasgreement	0	0
Qualified disagreement	2	8
Total	25	100

Agreement with this factor meant that the teacher strives to have his pupils develop an alert mind. He developes in his pupils the ability to recognize a problem, gather information, formulate a tentative hypothesis, test this hypothesis and modify, adapt or continue the process until the correct solution is reached. In order to develop these skills and attitudes in children, a teacher must first have developed them himself. Twenty-one or 84 per cent of the respondents agreed with this factor. This factor ranked five. It should be noted that two or 8 per cent qualified their agreement and the same per cent qualified their disagreement.

In general the respondents agreed with the "factors of effectiveness" which were postulated by Davis based on an exhaustive survey of the literature, and assessing of the opinion of science education experts. From this kind of acceptance on would assume that these teachers, in term of practice, would operate at a very high level of efficiency.

TABLE 18

SUMMARY DATA ON THE TWENTY-FIVE SECONDARY SCIENCE TEACHERS' REACTIONS TO THE SEVENTEEN FACTORS OF EFFECTIVENESS

No.	Criteria Factors of Effectiveness	Agree		Qualified Agreement		Disagree		Qualified Disagreement	
		No.	%	No.	%	No.	%	No.	%
1	Background Knowledge in Science and Related Fields	24	96	1	4	0	0	0	0
2	Functional Knowledge of Human Growth and Development	24	96	1	4	0	0	0	0
3	Knowledge of Methods of Instruction	22	88	2	4	0	0	1	4
4	Philosophy of Teaching	17	68	2	8	4	16	2	8
5	Citizenship and Leadership in the Community	22	88	2	8	0	0	1	4
6	Skill in Use of Classroom Aids and Devices	25	100	0	0	0	0	0	0
7	Teacher-Pupil Rapport	24	96	1	4	0	0	0	0
8	Extra-Contractual Occupations	21	84	2	8	1	4	1	4
9	Teacher-Supervisor Rapport	20	80	2	8	2	8	1	4
10	Excessive Responsibilities	25	100	0	0	0	0	0	0

TABLE 18--Continued

No.	Criteria Factors of Effectiveness	Agree		Qualified Agreement		Disagree		Qualified Disagreement	
		No.	%	No.	%	No.	%	No.	%
11	Science Curriculum of the School	20	80	3	12	1	4	1	4
12	Special Skills of the Youth in the Community	21	84	1	4	1	4	2	8
13	General Educational Needs of the Youth	17	68	3	12	4	16	1	4
14	Objectives of the Science Course	21	84	3	12	0	0	1	4
15	Laboratory Equipment	23	92	2	8	0	0	0	0
16	Physical Environment of the School	25	100	0	0	0	0	0	0
17	Scientific Attitudes	21	84	2	8	0	0	2	8

TABLE 19

SUMMARY DATA ON THE NUMBER AND RANK OF ACCEPTANCE OF THE CRITERIA SEVENTEEN FACTORS OF EFFECTIVENESS IN SCIENCE TEACHING AS INDICATED BY THE TWENTY-FIVE SECONDARY SCIENCE TEACHERS OF ATLANTA AND FULTON COUNTY

Factors	No. Accepting	Rank
1 - Background in Science and Related Fields	24	2
2 - Functional Knowledge of Human Growth and Development	24	2
3 - Knowledge of Methods of Instruction	22	4
4 - Philosophy of Teaching	17	7
5 - Citizenship and Leadership in the Community	22	4
6 - Skill in Use of Classroom Aids and Devices	25	1
7 - Teacher-Pupil Rapport	24	2
8 - Extra-Contractual Occupations	21	5
9 - Teacher-Supervisor Rapport	20	6
10 - Excessive Responsibilities	25	1
11 - Science Curriculum of the School	20	6
12 - Special Skills of the Youth of the Community	21	5
13 - General Educational Needs of Youth	18	7
14 - Objectives of the Science Course	21	5
15 - Laboratory Equipment	23	3
16 - Physical Envirnoment of School	25	1
17 - Scientific Attitude	21	5

Data on Personal Characteristics of Respondents

Sex and previous positions held.--The data on sex and positions held other than teaching as indicated by the twenty-five secondary science teachers are presented in Table 20, page 55 and analyzed in the following paragraph.

The data shows that the twenty-five respondents, fourteen or 56 per cent were males and eleven or 44 per cent were females. While it is true, in general, that in secondary science education, males far outnumber females. The percentage of respondents are almost equally distributed due to females being assigned to teach science more than ever before in the modern schools.

The data on positions, other than teaching, held during previous years, indicated that six different positions were held by nine or 36 per cent of the respondents. Sixteen or 64 per cent held no position, other than teaching. Although the difference between the respondents who held other positions and those who held no other position is small, it cannot be regarded as negligible. These teachers were selected as key persons around which the science program of each school evolved. The literature supports the 36 per cent who had held positions other than teaching in regard to a gain in functional understanding of the community and its economic life.

TABLE 20

SEX AND PREVIOUS POSITIONS HELD

Item	Number of Responses	Percentage
<u>Sex</u>		
Male	14	56
Female	11	44
<u>Positions held in previous years that defered valuable experience in science teaching</u>		
None	16	64
Research laboratory	4	16
Director of nature camp	1	4
Nurse	1	4
Cotton testing company	1	4
Revision of Georgia state science curriculum	1	4
Reading library in hospital	1	4
<u>Number years teaching experience in Atlanta and Fulton County</u>		
1-4	14	56
5-9	6	24
10-14	3	12
15 or more	2	8

The data on number of years of teaching experience in Atlanta and Fulton County revealed that fourteen or 56 per cent of the respondents had 1-4 years of teaching experience in Atlanta and Fulton County; six or 24 per cent had 5-9 years of teaching experience in Atlanta or Fulton County; three or 12 per cent had 10-14 years of teaching experience in Atlanta and Fulton County and two or 8 per cent had 15 or more years teaching experience in Atlanta or Fulton County.

Five or 20 per cent had more than ten years of teaching experience in Atlanta or Fulton County and twenty or 80 per cent had less than ten years of teaching experience in Atlanta or Fulton County.

Number of years of teaching in system other than Atlanta.--The data on the number of years of teaching experience in school systems than Atlanta and Fulton County indicated for the twenty-five secondary science teachers are presented in Table 21, page 57 and are analyzed below.

The data on number of years of teaching experience in other systems in Georgia revealed that six or 24 per cent had 1-4 years; and eight or 32 per cent had no years of teaching experience in other system in Georgia. Six or 24 per cent of the respondents did not reply to the question on teaching experience in other systems in Georgia.

The data also revealed that one or 4 per cent of the respondents had worked outside of the continental United States and three or 12 per cent had taught outside of Georgia but in the continental United States.

The data on the total number of years of teaching experience in Atlanta and Fulton County and other system re veal that three or 12 per cent of the respondents had 1-4 years of teaching experience; ten or 40 per cent had 5-9 years; four or 16 per cent had 10-14 years; five or 20 per cent had 15-19 years; and two or 8 per cent had more than 20 years of teaching experience. Fifty-two per cent had less than 10 years and 44 per cent had more than 10 years or more of teaching experences. One or 4 per cent did not reply to the question.

TABLE 21

NUMBER OF YEARS OF TEACHING IN SYSTEMS OTHER THAN ATLANTA

Item	Number of Responses	Percentage
Number of years teaching in other systems in Georgia		
None	8	32
1-4	6	24
5-9	5	20
Unknown	6	24
Number of years teaching outside of Georgia, but in the United States		
None	22	88
1-4	3	12
Number of years teaching outside of United States		
None	24	96
1-4	1	4
Total Experience outside Atlant and Fulton County		
None	7	28
1-4	9	36
5-9	5	20
Unknown	4	16
Total experience in Atlanta and Fulton County and other systems		
1-4	3	12
5-9	10	40
10-14	4	16
15-29	5	20
20 or more	2	8
Unknown	1	4

<u>Degrees and certificates held and colleges attended</u>.--The data on degrees held, colleges attended, year of graduation, and certificates by the twenty-five secondary science teachers are presented in Table 22, page 59, and analyzed in the separate paragraphs below.

The data on highest degree held indicated that seven or 28 per cent held B. A. degrees; six or 24 per cent held B. S. degrees; nine or 36 per cent held M. A. degrees; and three or 12 per cent held M. S. degrees. One of the respondents held a DTS-6 degree.

The data on colleges attended revealed that the twenty-five respondents attended eleven colleges located in four states including Georgia. Three or 12 per cent attended Morehouse College; three or 12 per cent attended Fort Valley State College; with the remaining 24 per cent interspersed between six other colleges located in four states; Louisiana, Florida, Georgia, and North Carolina. The greatest percentage, sixteen, attended Morris Brown College which is located in the community.

One or 4 per cent of the respondents graduated before 1939; seven or 28 per cent graduated between 1940-1949; twelve or 48 per cent graduated between 1950-1959; three or 12 per cent graduated between 1960-1965. The greatest number and percentage of the respondents graduated between 1950 and 1959 which was 48 per cent of the respondents used in this study.

The data on types of certificates held revealed that six or 24 per cent of the respondents held T-4 (professional secondary) certificates; six or 24 per cent held DT-4 (professional secondary, life) certificates; five or 20 per cent held T-5 (professional secondary) certificates; eight or 32 per cent held DT-5 (life professional secondary) certificates; and one or 4 per c ent of the respondents held a DTS-6 (life professional secondary) certificate. Twenty-five or 100 per cent of the respondents were certificated to teach science in the secondary school. Most of the respondents, 8 per cent, held DT-5 (life professional secondary) certificates.

TABLE 22

DEGREES AND CERTIFICATES HELD AND COLLEGES ATTENDED

Item	Number of Responses	Percentage
Highest degree held		
AB	7	28
BS	6	24
MA	9	36
MS	3	12
DTS-6	1	4
College attended		
Albany State	1	4
Clark	3	12
Dillard	1	4
Florida A & M	1	4
Fort Valley	3	12
Livington	1	4
Morehouse	3	12
Morris Brown	4	16
Paine	3	12
Savannah State	1	4
Spelman	1	4
Unknown	3	12
Year of graduation		
-1939	1	4
1940-1949	7	28
1950-1959	12	48
1960-1965	3	12
Unknown	2	8

TABLE 22--Continued

Item	Number of Responses	Percentage
Type of certificate		
T-4	6	24
DT-4	6	24
T-5	5	20
DT-5	8	32
P-5	1	4
DTS-6	1	4

Identification with school-community factors and/or activities.--Table 23, page 61, presents the data on civic participation, school enrollment, subjects and grades taught by thetwenty-five secondary science teachers.

The data on community organizations, participated in by the respondents as leaders, revealed that of the twenty-five respondents, fifteen or 60 per cent participated in no community organizations; two or 8 per cent participated as Girl Scouts leaders; three or 12 per cent participated as a Boy Scouts leader; three or 12 per cent participated as a Y-Teen leader; and one or 4 per cent participated as an Ivy Leaguer leader. This percentage has significance in the application of factor number four in regard to "exerting community leadership to one's educational pattern."

Table 23, also shows that thirteen or 52 per cent of the respondents taught in schools with enrollment of 1,200 or more, five or 20 per cent taught in schools with enrollments of 1,700-2,199; two or 8 per cent taught in schools with enrollments of 1,200-1,699; five or 20 per cent taught in schools with enrollments of 700-1,199; three or 12 per cent taught in schools with enrollments of 200-699. The greatest percentage of the respondents taught in schools with enrollments of more than twenty-two hundred students.

Again, Table 23 shows that the data on major areas of teaching assignment indicated that five or 20 per cent of the respondents teach chemistry; six or 24 per cent teach general science; one or 4 per cent teach physics; eleven or 44 per cent teach general biology. One or 4 per cent did not indicate his major teaching area and one or 4 per cent had some other subject as his major teaching assignment.

TABLE 23

IDENTIFICATION WITH SCHOOL-COMMUNITY ACTIVITIES

Item	Number of Responses	Percentage
Youth leader in out-of-school activities		
Boy Scouts	3	12
Girl Scouts	2	8
Y-Teen	3	12
Ivy Leagurers	1	4
None	15	60
Unknown	1	4
School Enrollment		
200-699	3	12
700-1,199	5	20
1,200-1,699	2	8
1,700-2,199	5	20
2,200 or more	6	24
Unknown	4	16
Major grade assignment		
Chemistry	5	20
Physics	1	4

TABLE 23--Continued

Item	Number of Responses	Percentage
Major grade assignment		
Biology	11	44
General science	6	24
Others	1	4
Unknown	4	16
Grade taught		
8	2	8
8-10	1	4
8-12	18	72
9-12	2	8
10-12	1	4
Unknown	1	4

Size of classes taught.--Table 24, page 63 presents the data on size of classes taught by the twenty-five secondary science teachers.

None of the respondents taught classes with sizes that ranged below twenty. One or 4 per cent taught classes with sizes that ranged from 20-24; six or 24 per c ent taught classes with sizes that ranged from 25-29; thirteen or 52 per cent taught classes with sizes that ranged from 30 or more; five or 20 per cent did not indicate the size of their class. The majority of the class sizes are questionable in the application of factor number ten in regards to carrying an excessive load by reason of an excessive number of pupils. The literature regard the opportunity to adapt teaching to the individual diminishes rapidly as classes exceed twenty-five pupils.

TABLE 24

SIZE OF CLASSES TAUGHT

Item	Number of Responses	Percentage
Range of class sizes		
20-24	1	4
25-29	6	24
30 or more	13	52
Unknown	5	20

Leadership and membership in church, civic, and scientific organizations.--Table 25, page 64, presents the data on leadership and/or membership in church, civic, and scientific organizations held by the twenty-five secondary science teachers.

The data from the respondents indicated that eleven or 44 per cent were actively engaged in church activities; five or 20 per cent were Sunday school teachers. Other positions of leadership in the church assumed by the respondents were that of usher, steward, choir, membership coordinator, treasurer of church credit union and church basketball coach. However, it should be noted that fourteen or 56 per cent of the respondents did not engage in any role of leadership in church organizations.

The data concerning other organizations which was relatively ineffectual in its influence upon secondary education indicated that twelve or 48 per cent of the respondents were members of some fraternity or sorority; four or 16 per cent of the respondents were Masons; one or 4 per cent of the respondents was a member of the civil defense and one or 4 per cent was a member of the Elks organization. Nine or 36 per cent of the respondents were not members of any fraternal, social or service organizations.

The data on membership in science or scientific organizations from the respondents indicated that fifteen or 60 per cent of the respondents are members of the National Science Teachers Association; four or 16 per cent are members of the National Biology Teachers Association; three or 12 per cent are members of the American Mathematics and Science Teachers Association; two or 8 per cent are members of the Beta Kappan Chi Scientific Society and seven or 28 per cent belong to a variety of other organizations.

TABLE 25

LEADERSHIP IN COMMUNITY ACTIVITIES

Item	Number of Responses	Percentage
Leadership in church organizations		
None	14	56
Steward	1	4
Sunday school teacher	5	20
Usher	1	4
Membership coordinator	1	4
Treasurer of church credit union	1	4
Choir	1	4
Church basketball coach	1	4
Membership in fraternal, social or service organizations		
None	9	36
Masons	4	16
Fraternities and sororities	12	48

TABLE 25--Continued

Item	Number of Responses	Percentage
Membership in fraternal, social or service organizations		
Civil Defense	1	4
Elks	1	4
To what scientific organizations do you belong		
NSTA	15	60
NBTA	4	16
AMSTA	3	12
BKCSS	2	8
Others	7	28

Professional Characteristics of the Respondents

Undergraduate professional and academic training.--Table 26, page 66, presents data on professional and academic training of the twenty-five secondary science teachers.

The data indicated that four or 16 per cent of the respondents did not indicate any undergraduate semester hours in general professional education; two or 8 per cent had 9-14 credit hours; six or 24 per cent had 15-20 credit hours; eight or 32 per cent had 21-26 credit hours; four or 16 per cent had 27-32 credit hours; and one or 4 per cent had more than 33 credit hours.

The data on undergraduate major field of concentration revealed that five different fields of concentration were represented by the twenty-five respondents. Seventeen or 68 per cent had biology as their undergraduate fields of concentration; ten or 40 per cent had chemistry as their undergraduate fields of concentration; five or 20 per cent had physics as their fields of concentration. One or 4 per cent had physical education as his major field of concentration. Twenty-four or 96 per cent of the respondents were science majors. It should be noted that some of the respondents had double majors.

TABLE 26

UNDERGRADUATE PROFESSIONAL AND ACADEMIC TRAINING

Item	Number of Responses	Percentage
Undergraduate credit hours in general professional education		
9-14	2	8
15-20	6	24
21-26	8	32
27-32	4	16
33 or more	1	4
Unknown	4	16
Undergraduate major field of concentration		
Mathematics	3	12
Biology	17	68
Chemistry	10	40
Physics	5	20
Others	1	4

<u>Graduate schools attended and graduate credit in areas of Concentration</u>.--The data on graduate schools attended and areas of graduate study indicated for the twenty-five secondary science teachers are presented in Table 27, page 68, and analyzed under appropriate captions below.

Undergraduate minor field.--The data indicated that three or 12 per cent of the respondents had secondary education as their undergraduate minor fields of concentration; nine or 36 per cent had chemistry as their minor fields of concentration; four or 16 per cent had biology as their undergraduate minor fields of concentration; five or 20 per cent had mathematics as their undergraduate fields of contraction; one or 4 per cent had physics as their undergraduate minor field of concentration. Four or 16 per cent has no minor field of concentration.

Areas of graduate work.--The data indicated that twenty-three or 92 per cent of the respondents had done graduate work; three or 12 per cent had no major; four or 16 per cent had biology as their major fields of concentration; four or 16 per cent had science education; four or 16 per cent had chemistry; two or 8 per cent had not done any graduate work. The greater percentage felt that it was important to keep up with new professional developments by continuing their education.

Graduate school attended.--Eighteen or 72 per cent of the respondents attended Atlanta University, ranking it one; two or 8 per cent attended New York University and Michigan State, ranking them two. Other universities attended by the respondents were Tennessee State, Morgan State, Cornell, Howard, Yale, Notre Dame and Ohio State University. Only one of the twenty-five respondents did not list the institution in which he did graduate work.

Graduate credit earned.--Of the twenty-five respondents, five or 20 per cent had no semester credit hours of graduate professional education graduate work; one or 4 per cent had 6-11 professional education graduate credit hours; two or 8 per cent had 12-17 professional education graduate credit hours; five or 20 per cent had 18-23 graduate credit hours; seven or 28 per cent had 30 or more graduate credit hours. Five or 20 per cent of the respondents did not list their graduate credit hours in professional education.

Of the twenty-five respondents, eight or 32 per cent had done post graduate work. Of the eight, three or 12 per cent did this work at Atlanta University. Post graduate schools listed were Wake Forest, University of Illinois, Cornell, Xavier, University of Georgia, Wesleyan and Villanova. Seventeen or 68 per cent of the respondents had not done any post graduate work.

TABLE 27

GRADUATE SCHOOL ATTENDED AND CREDITS EARNED

Item	Number of Responses	Percentage
Undergraduate minor field of concentration		
Chemistry	9	36
Physics	1	4
Biology	4	16
Mathematics	5	20
Secondary education	3	12
None	4	16
Others	6	24
Graduate work		
Yes	23	92
No	2	8
Graduate school attended		
None	1	4
Atlanta University	18	72

TABLE 27--Continued

Item	Number of Responses	Percentage
Graduate school attended		
Tennessee State	1	4
Morgan State	1	4
Cornell	2	4
N.Y.U.	2	8
Howard	1	4
Michigan State	2	8
Yale	1	4
Notre Dame	1	4
Ohio State	1	4
Graduate hours in professional education		
None	5	20
6-11	1	4
12-17	2	8
18-23	5	20
24-29	0	0
30 or more	7	28
Unknown	5	20
Graduate major field of concentration		
None	3	12
Physics	2	8
Mathematics	1	4
Science Education	4	16
Biology	4	16
Chemistry	4	16
Others	4	16
Unknown	4	16
Graduate minor field of concentration		
None	20	80
Mathematics	1	4
Biology	1	4
Chemistry	1	4
Secondary education	1	4
Natural science	1	4

Credits earned in the sciences.--Table 28, page 71, presents data on respondents' credit hours earned in certain areas of science. Five or 20 per cent had 2-6 semester hours in physics; seventeen or 68 per cent had had 7-12 semester hours in physics giving it a rank of three. One or 4 per cent had had 2-6 semester hours in chemistry; eitht or 32 per cent had had 7-12 semester hours in chemistry; six or 24 per cent had had 13-18 semester hours in chemistry; five or 20 per cent had had 19-24 semester hours in chemistry; and five or 20 per cent had had 24 or more semester hours in chemistry; ranking it one. Five or 20 per cent had had 2-6 semester hours in zoology; nine or 36 per cent had had 7-12 semester hours in zoology; two or 8 per cent had had 13-18 semester hours in zoology; one or 4 per cent had had 19-24 semester hours in zoology; and three or 12 per cent had had 25 or more semester hours in zoology, ranking it two. Two or 8 per cent had 2-6 semester hours of geology; two or 8 per cent had had 2-6 hours in astronomy; eleven or 44 per cent had had 2-6 semester hours in botany; five or 20 per cent had had 6-12 semester hours in botany; thirteen or 52 per cent had had 2-6 semester hours in bacteriology. In other words 20 per cent of the respondents had had courses in chemistry. Eighty-eight per cent of the respondents had had courses in zoology, and almost all of the respondents had had courses in other sciences. This evidence of considerable preparation in science weighs in favor of factor one in regard to broad background of knowledge in science.

TABLE 28

Semester Hours in Particular Sciences

Physics

None	0
2-6	5
7-12	17
13-18	2
31-36	1

Chemistry

None	0
2-6	1
7-12	8
13-18	6
19-24	5
35-30	0
31-36	2
37-or more	3

Zoology

None	0
2-6	5
7-12	9
13-18	2
19-24	1
25-30	3
31-36	2

Botany

None	8
2-6	11
7-12	5
13-18	1

Bacteriology

None	11
2-6	13
7-12	1

Astronomy

None	22
2-6	2
7-12	1

Physiology and Health Science

None	17
2-6	5
7-12	1
13-18	1
19-24	0
25-30	1

Geology

None	23
2-6	2

Georgraphy

None	22
2-6	3

General Science

None	
2-6	14
7-12	5
13-18	5
19-24	0
25-30	1

Meteorology

None	24
2-6	1

TABLE 29

PARTICULAR SCIENCES STUDIED BY THE RESPONDENTS

Particular Science	Number of Respondents Studying the Subject	Percentage	Rank
Botany	17	68	4
Chemistry	25	100	1
Physics	20	80	3
Zoology	22	88	2
Bacteriology	14	56	5
Physiology and Health Science	8	32	7
General Scienc	11	44	6
Geography	3	12	8
Astronomy	3	12	8
Geology	2	8	9
Meteorology	1	4	10

TABLE 30

POST-GRADUATE WORK

Item	Number of Responses	Percentage
Science courses offered in high school		
Biology	25	100
BSCS	6	24
Chemistry	23	92
CBA	1	4

TABLE 30--Continued

Item	Number of Responses	Percentage
Science courses offered in high school		
General Science	25	100
Physics	25	100
PSSC	3	12
Unknown	1	4
Other		
Post graduate work		
Yes	8	32
No	17	68
Post graduate school attended		
None	17	68
Cornell	1	4
Wake Forest	1	4
University of Illinois	1	4
Atlanta University	3	12
Xaviar	1	4
University of Georgia	1	4
Wesleyan	1	4
Emory	1	4
Villanova	1	4

Activities in science.--Table 32, page 74, presents data on avtivities of science teaching as listed by the respondents. Sixteen or 64 per cent of the respondents had done no work which offered valuable experience to them in science teaching that did not appear on their transcripts; one respondent had worked in electronics; and two had participated in the BSCS training program. In other words, nine or 36 per cent had worked at some job which they regarded as having valuable to them in teaching science. Eleven or 44 per cent had had no hobby of value to them in teaching science; fourteen or 56 per cent had a hobby or hobbies which they regarded as being of value in teaching science. Sixteen or 64 per cent had done nothing that was not listed on their school transcript which was of value to them in teaching science. Nine or 36 per cent had done work which they regarded as of value to them in teaching science.

TABLE 31

HOBBIES AND WORK HELPFUL IN SCIENCE TEACHING

Item	Number of Responses	Percentage
What hobby or hobbies do you have that offer valuable aid to you in teaching science?		
None	11	44
Photography	5	20
Sketching	2	8
Reading	5	20
Entomology	2	8
Gardening	1	4
Parasitology	1	4
Radio	1	4
Geology	1	4
What work have you done which is helpful in science teaching but does not appear on you transcript?		
None	16	64
Electronics	1	4
BSCS	2	8

TABLE 31--Continued

Item	Number of Responses	Percentage
What work have you done which is helpful in science teaching but does not appear on your transcript?		
Radiological Monitor	16	64
ARC welding	1	4
Metallurgy	2	8
Physical science institute	1	4
Leadership school	1	4
Geology	1	4

Periodidals read.--Table 32, page 76, presents the data from the respondents indicating that ten or 40 per cent of the teachers read The Science Teacher regularly; seven or 28 per cent read Scientific American regularly and three or 12 per cent read Science Educator's Society and Children and Science regularly; two or 8 per cent read Science Education, Science Weekly and The Journal of Chemical Education regularly; seven or 28 per cent indicated that they read some other science or science education magazine regularly. Three or 12 per cent of the respondents indicated that they read School Science and Mathematics occasionally. It is mandatory that science teachers keep abreast of the changes taking place in their field as well as other related fields.

TABLE 32

PERIODICALS READ

Item	Number of Reponses	Percentage	Rank
What science or science education magazine do you read?			
Regularly			
None	5	20	3
Science Teacher	10	40	1
Scientific American	7	28	2
Science Educator's Society	3	12	4
Children and Science	3	12	4
Science Education	2	8	5
Current Science	2	8	5
Science Weekly	2	8	5
Journal of Chemical Education	2	8	5
Others	7	28	
Occasionally			
School Science and Mathematics	3	12	
Science Digest	2	8	
Others	10	40	
None	4	16	

In regard to activities related to science teaching, 64 per cent of the respondents had done no work which offered valuable experience to them in science teaching; 44 per cent had no hobby or hobbies which offered valuable experiences; 64 per cent had no school work which was not listed on their transcripts which offered valuable experience; 20 per cent had read no science or science education magazines regularly and 16 per cent had read none occasionally. These percentages of the respondents who engaged in no activities which they regarded as valuable to them in science teaching weighs negatively in regard to factor number one in terms of a broad background of related scientific areas. This is perhaps due to securing teaching positions immediately after graduating from college. By implication, this means that they must be provided ample experience in their college training or immediately become associated with some in-service training program.

Civic participation and school duties aside from teaching.--Table 33, page 78, presents the data on civic participation and school duties other than teaching as shown by the twenty-five secondary science teachers.

The respondents reactions to participation in community drives indicated that nine or 36 per cent of the teachers did not participate in these drives; four or 16 per cent participated in cancer and red cross drives; two or 8 per cent participated in community chest and ten or 40 per cent participated in other community drives.

Data indicated that twenty or 80 per cent of the respondents took part as leaders in movements for the common good of the community. Ninety-six per cent of the respondents indicated that their communities allow them to lead normal lives.

Data from the respondents indicated that teachers must perform many duties aside from teaching. Twenty-two extra-curricular school activities and duties were listed. Listed among these duties were science club advisor, hall duty, school paper advisor, homeroom advisor

National Honor Society advisor, game duties, coaching, department head, schedule chairman. Twelve or 48 per cent thought that some of these activities were harmful to the science teaching program, seven or 28 per cent thought these activities were helpful to the science teaching program and six or 24 per cent thought the extra-curricular activities made no difference to the science teaching program.

Eight or 32 per cent of the respondents indicated that teachers are expected to perform certain duties in the community because of their position. Five or 20 per cent indicated that many community duties are harmful to teaching efficiency, however, nine or 36 per cent that it made no difference.

TABLE 33

CIVIC PARTICIPATION AND SCHOOL DUTIES ASIDE FROM TEACHING

Item	Number of Responses	Percentage
Participation in community drives		
None	9	36
Red cross	4	16
Cancer	4	16
Community chest	2	8
Others	9	36
Leadership in movements for the common good		
Yes	20	80
No	4	16
Unknown	1	4
Does your community allow teachers to lead normal lives?		
Yes	24	96
No	1	4

TABLE 33--Continued

Item	Number of Reponses	Percentage
School duties aside from teaching		
Science club advisor	4	16
Hall duty	4	16
Newspaper (school) advisor	3	12
Homeroom advisor	4	16
National Honor Society advisor	3	12
Game duties	2	8
Coaching	2	8
Department head	2	8
Schedule chairman	2	8
Others	13	52

Effect of extra-curricular activities, other occupations, and number of preparations.--The data on the effect of extra-curricular activities, other occupations and number of daily preparations are presented in Table 34, pages 80 and 81.

Data from the respondents indicated that 48 per cent of the teachers felt that extra-curricular activities are harmful to science teaching and 32 per cent felt that teachers are given duties in their communities because of their positions.

The respondents indicated that sixteen or 64 per cent of the teachers had no occupations other than teaching, and only two or 8 per cent spent more than twenty hours per week in other occupations.

Six or 24 per cent of the respondents indicated that the total number of pupils in their classes was less than ninety-nine. Two or

8 per cent had 100-119; twelve or 48 per cent had 120-139; five or 20 per cent had 140-159; and none of the respondents had more than 160 pupils in their classes.

The respondents indicated that only three or 12 per cent prepared four daily lesson plans. Seven or 28 per cent of the respondents prepared three daily lesson plans; nine or 36 per cent prepared two; and six or 24 per cent prepared one daily lesson plan. However, it was interesting to note that 76 per cent of the respondents had no study halls, and six or 24 per cent had only one.

TABLE 34

EFFECT OF EXTRA-CURRICULAR ACTIVITIES AND PREPARATION

Item	Number of Responses	Percentage
Effect of extra-curricular activities on science teaching		
Harmful	12	48
Helps	7	28
No difference	6	24
Are teachers in communities given duties because of their positions?		
Yes	8	32
No	7	28
Unknown	10	40
Are community duties harmful to teaching efficiency?		
Harmful	5	20
Helpful	6	24
No difference	9	36
No opinion	5	20

TABLE 34--Continued

Item	Number of Responses	Percentage
Hours per week in occupations other than teaching		
None	16	64
1-10	5	20
11-20	2	8
Over 20	2	8
Total number of pupils in class		
80 or less than 99	6	24
100-199	2	8
120-139	12	48
140-159	5	20
Number of preparations		
4	3	12
3	7	28
2	9	36
1	6	24
Number of study halls		
2	0	0
1	6	24
None	19	76

Data on Methods and Materials of Instruction

Use of movies, filmstrips and filmslides in science teaching.--Data concerning the respondents' reactions to questions on the use of movies, filmstrips and filmslides which are used in teaching science in the secondary school with which these teachers are identified are presented in Table 35, page 82.

In their teaching 64 per cent of the respondents used movies frequently; 36 per cent used movies occasionally; 100 per cent of the respondents could operate a 16 mm movie projector; 80 per cent could make minor adjustments and repairs to a picture projector; 96 per cent used filmstrips; 72 per cent could make slides appropriate for use in a science class but only 60 per cent made and used such slides; 80 per cent could operate recording and transcribing devices; none of the respondents used recording devices frequently; 60 per cent used them occasionally and 40 per cent did not use them at all.

TABLE 35

USE OF MOVIES, FILMSTRIPS AND FILMSLIDES

Item	Number of Responses	Percentage
Do you use movies frequently?		
Frequently	16	64
Occasionally	9	36
Not at all	0	0
Can you repair and adjust a moving picture projector?		
Yes	20	80
No	5	20
Do you use filmstrips or filmslides?		
Frequently	12	48
Occasionally	12	48
Not at all	1	4
Can you make slides?		
Yes	18	72
No	7	28

TABLE 35--*Continued*

Item	Number of Responses	Percentage
Do you make slides?		
Yes	15	60
No	10	40
Can you operate:		
Moving picture projector		
Yes	25	100
No	0	0
Filmstrip projector		
Yes	25	100
No	0	0
Recording and transcribing devices		
Yes	20	80
No	5	20
Do you use recording and transcribing devices?		
Yes	15	60
No	10	40

Models, exhibits, and demonstrations in science teaching.--Table 36, page 84, presents the data on the use of models and exhibits and the effects of the lack of equipment in presenting demonstrations to science classes.

Thirty-six per cent of the respondents indicated that they or members of their classes frequently wished to carry out experiments or demonstations for which equipment was not available; 64 per cent indicated that this happened occasionally; none of the respondents indicated that this never happened. The teachers who frequently, and those who occasionally, experminted the lack of available equipment to carry out experiments and demonstrations offered, apparently recognized the importance of the construction of these aids to increase the effectiveness of their science teaching. Eighty per cent used models, and live exhibits frequently; 16 per cent used them occasionally and 4 per cent did not use them at all; 36 per cent frequently constructed models when they were available; 60 per cent constructed them occasionally when they were available; 4 per cent did not construct them at all.

TABLE 36

MODELS, EXHIBITS, AND DEMONSTRATIONS

Item	Number of Responses	Percentage
Do you use models, exhibits, etc.?		
Frequently	20	80
Occasionally	4	8
Not at all	1	4
Do you or members of your class construct models and exhibits?		
Frequently	9	36
Occasionally	15	60
Not at all	1	4
Does lack of equipment prevent some demonstrations?		
Frequently	9	36
Occasionally	16	64
Not at all	0	0

Teacher planning and competence.--Table 37, page 85, presents the data on teacher competence and the use or lack of use of students in the planning of units in science.

The data indicated that 88 per cent of the respondents felt thoroughly competent to work with normal laboratory and demonstration equipment in secondary school science; 4 per cent did not feel competent to work with normal laboratory and demonstration equipment in secondary school science, and 8 per cent indicated they were partically competent when working with laboratory equipment. It is assumed that most of the teachers have developed whatever competencies they possess and that most of them are providing the children with experiences which require the use of equipment and materials in science. Sixty-eight per cent of the respondents indicated that they frequently allowed students to help with the planning of their work; 32 per cent did not allow the students to help in the planning of their work.

TABLE 37

TEACHING PLANNING AND COMPETENCE

Item	Number of Responses	Percentage
Are you competent when working with laboratory equipment?		
Thoroughly	22	88
Partically	2	8
Unknown	1	4
Planning of teaching		
Teacher	8	32
Teacher-Student	17	68

<u>Resource units, textbooks, and tests</u>.--Table 38, page 87, presents the data on the use of resource units, textbooks and tests in the teaching of secondary science.

The data indicated that twenty-three or 92 per cent of these teachers stated that they had used a resource unit; however, only twelve or 48 per cent indicated that they were using such a unit at the time of this study. Two or 8 per cent had never used a resource unit.

Fourteen or 46 per cent usually followed the direction of the textbook in the development of a plan of teaching. Four or 16 per cent always followed the organization of a particular textbook's organization; 16 per cent of the respondents made use of two basic textbooks regularly as sources of information. Six or 24 per cent used only one. Twenty-one or 84 per cent occasionally gave tests other than those of their own construction.

Twenty-four or 96 per cent of the teachers were familiar with at least two sources of printed tests. One or 4 per cent was not familiar with two sources of printed tests. The response to test giving appeared valid in light of their statement of a knowledge of standardized texts and these teachers were in line with modern trends pertaining to the use of such tests.

The use of resource units may be considered as an index of the extent to which these teachers are seriousley concerned with teacher-pupil planning, cooperative sharing in the making of decisions, and similar aspects to which some refer to as the "democratic process of education."

TABLE 38

RESOURCE UNITS, TEXTBOOKS AND TESTS

Item	Number of Responses	Percentage
Have you used a resource unit within the past two years?		
Yes	23	92
No	1	4
Unknown	1	4
Do you follow the organization of a particular textbook?		
Always	4	16
Usually	14	56
No	7	28
Are you now using a resource unit?		
Having used	11	44
Now using	12	48
Never used	2	8
Do you use one or more basic text?		
One	6	24
Two	4	16
More than two	14	56
Unknown	1	4
Do you give tests other than those of your own construction?		
Frequently	9	36
Occasionally	12	48
Not at all	3	12
Unknown	1	4
Are you familiar with at least two printed tests in science?		
Yes	24	96
No	1	4

Use of community resources.--Data on methods and materials of community resources as indicated by the respondents is presented in Table 39, page 89.

Sixty-eight per cent of the respondents occasionally made use of the community for learning experiences outside of the classroom. Five or 20 per cent frequently used the community; 12 per cent never used the community for learning purpose outside the classroom. Two or 8 per cent frequently brought local materials and community resources (including speakers) into the classroom. Seventeen or 68 per cent occasionally used these types of resources and five or 20 per cent never brought community resources and materials into the classroom.

Twenty-one or 84 per cent of these teachers used school or public library materials frequently as sources for their work in science, or 16 per cent used shcool and public library materials occasionally. None of the respondents indicated they never use school and/or public library materials. Table 39 shows that eighteen or 72 per cent of the teachers were familiar with the resources for science teachers from the museum, State Department of Agriculture, etc. Seven or 28 per cent were not familiar with them. Three or 12 per cent of the respondents used them occasionally; seven or 28 per cent never used government publications from the Bureau of Mines at all. The State Department of Agriculture, Commerce, Health and others provide numerous exhibits which are available to the schools for visitation.

TABLE 39

USE OF COMMUNITY RESOURCES

Item	Number of Responses	Percentage
Do you use community for taking science classes outside?		
Frequently	5	20
Occasionally	17	68
Not at all	3	12
Do you bring local and community resources into the class?		
Frequently	2	8
Occasionally	17	68
Not at all	5	20
Unknown	1	4
Is the school or public library used for reference?		
Frequently	21	84
Occasionally	4	16
Not at all	0	
Are you familiar with resources from museum and State Department of Agriculture?		
Yes	18	72
No	7	28
Do you use publications from the Bureau of Mines, United States Department of Mines?		
Frequently	3	12
Occasionally	15	60
Not at all	7	28

Use of professional guides.--Table 40 presents the data on the use of state and local guides by the science teachers.

The data pertaining to resources consulted in planning the science program indicated that 52 per cent of the respondents consulted the state guide very often; 28 per cent used it occasionally and 20 per cent rarely or never used the state guide at all. Sixty per cent used their local school guide very often; 24 per cent used it occasionally; 12 per cent rarely or never used it and 4 per cent did not indicate if the local school guide was consulted in his planning. Eighty-four per cent of the respondents used their own ideas in formulating their lesson plans; and 16 per cent did so occasionally.

TABLE 40

USE OF PROFESSIONAL GUIDES

Item	Number of Responses	Percentage
Are these resources consulted in your planning?		
State guide:		
Very often	13	52
Occasionally	7	28
Rarely or never	5	20
Local school guide:		
Very often	15	60
Occasionally	6	24
Rarely or never	3	12
Unknown	1	4
Your own ideas:		
Very often	21	84
Occasionally	4	16
Rarely or never	0	

Science clubs and fairs.--Table 41, page 91, presents the respondents' knowledge of and participation in science clubs and state and local science fairs.

Data indicates that twenty-three or 92 per cent of the respondents were familiar with the work of Science Club of America. The same percentage indicated that they were familiar with the low cost and free materials available through the Science Club of America. Two or 8 per cent were familiar with these materials. Seven or 28 per cent of the respondents used them frequently; sixteen or 64 per cent used them occasionally; and one or 4 per cent never used them. Twenty-one or 84 per cent of the respondents participated in science fairs within the last two years. Four or 16 per cent had not participated.

Seventeen or 68 per cent of these teacher indicated that they did not participate or know of the Junior Academy of Science. This lack of knowledge and participation was due to race problems. Negroes were not allowed to participate prior to this study.

TABLE 41

SCIENCE CLUBS AND FAIRS

Item	Number of Responses	Percentage
Are you familiar with Science Club of America?		
Yes	23	92
No	2	8
Are you familiar with the Junior Academy of Science?		
Yes	17	68
No	8	32

TABLE 41--Continued

Item	Number of Responses	Percentage
Have you participated in local or state science within the last two years?		
Yes	21	84
No	4	16

Funds for purchasing equipment, supervision and free and low cost materials.--Table 42, page 93, presents the data on the science teachers' knowledge of money per pupil for purchasing science qeuipment, supervisory help in the school and the knowledge and use of free and low cost materials.

Thd data indicated that seventeen or 68 per cent of the respondents did not know how much money per pupil had been allocated in the past two years for purchasing materials and supplies for the teaching of science. The lack of knowledge indicated a deficiency on the behalf of the administration, head of science department and the respondent.

Data from the respondents indicated that other than assistance from the principal, supervisory help in teaching science was available within the school. Twenty-two or 88 per cent indicated this in their response to the above fact. Three or 12 per cent indicated no supervisory help within the school. Six or 24 per cent used help very often; eight or 32 per cent used it occasionally; and five or 20 per cent did not use this supervision at all.

Ninety-two per cent of the respondents were familiar with listings of free and low cost materials, but only 28 per cent used them frequently; 64 per cent used the materials occasionally; and 4 per cent did not use the materials at all.

Data from the respondents indicated that 36 per cent of the science teachers felt that they had ample supplies and materials in their classrooms to fulfill the aims of the course being taught; 68 per cent felt that the materials and supplies were almost adequate and 16 per cent indicated that materials and supplies were inadequate for effective science teaching.

TABLE 42

FUNDS, SUPERVISION AND LOW COST MATERIALS

Item	Number of Responses	Percentage
Amount of money per pupil for purchasing laboratory equipment		
Less than $1	3	12
$1-$4	2	8
$5-$9	3	12
Unknown	17	68
Is there supervisory help in your school other than the principal?		
Yes	22	88
No	3	12
If this supervisory help is present, do you use it?		
Very often	6	24
Occasionally	8	32
Rarely or never	5	20
Unknown	6	24

TABLE 42--Continued

Item	Number of Responses	Percentage
Are you familiar with listings of free and low cost materials?		
Yes	23	92
No	2	8
Do you make use of such listings to obtain materials?		
Frequently	7	28
Occasionally	16	64
Not at all	1	4
Unknown	1	4
Do you have adequate supplies and materials?		
Yes	9	36
Almost	17	68
Inadequate	4	16

Data Pertaining to Facilities and Equipment

Facilities and equipment.--Table 43, page 95, presents the data on facilities, equipment and furnishings in the classroom of the twenty-five secondary science teachers.

The physical environment of the science departments, as indicated by 72 per cent of the respondents, were good; 20 per cent were fair and only 8 per cent of the respondents indicated that physical environment was poor. Twenty or 80 per cent indicated that the laboratory furniture was in good condition and 92 per cent stated that their instruments, devices, and materials were in useable condition. Nineteen or 76 per cent indicated that their rooms were properly painted; 44 per cent stated that their ventilation and heating systems were excellent and the same per cent thought that it was usually satisfactory; only 12 per cent indicated that their system for ventilating and heating were seldom satisfactory. Seventy-six per cent of the respondents indicated that the janitoral service was adequate or fairly adequate and 24 per cent thought the janitoral.service was poor.

A room that is well painted, attractive, with proper heating, lighting, and ventilation encourages pleasantness and receptive minds.

TABLE 43

FACILITIES AND EQUIPMENT

Item	Number of Responses	Percentage
Physical environment of science department		
Good	18	72
Fair	5	20
Poor	2	8
Laboratory furniture		
Good	20	80
Fair	3	12
Poor	1	4
Unknown	1	4
Instruments, devices and materials		
Condition to use	23	92
Need of repair	2	8
Is your room well-painted?		
Yes	19	76
Fairly well-painted	3	12
Poorly painted	2	8
Unknown	1	4

TABLE 43--Continued

Item	Number of Responses	Percentage
Janitorial service		
Adequate	9	36
Fairly adequate	10	40
Poor	6	24
Ventilation and heating		
Excellent	11	44
Usually satisfactory	11	44
Seldom satisfactory	3	12
Is your room equipped with proper window and movic shades?		
Yes	13	52
No	12	48

Data on Provisions for Students with a Special Aptitudes and Interests in Science

Differentiated teacher-student activities.--Table 44, page 98, presents data from the respondents concerning interest in students with special interests and aptitudes in science.

Sixteen or 64 per cent of the respondents indicated that they very often gave considerable responsibility to special students in connection to the class duties assigned; eight or 32 per cent did this occasionally. This provision indicated that the teachers were in agreement with the literature in providing for individual difference among students.

Forty per cent of the respondents indicated that they often gave additional assignments to special students which were not required by all the students. Fifty per cent did this occasionally. Sixteen per cent indicated some students very often engaged in science projects not designed for the entire class; 68 per cent did this occasionally.

Thirty-six per cent of the respondents indicated that special students very often perform demonstrations or experiments before the class; 52 per cent did this occasionally and only 4 per cent did this rarely. Forty-four per cent indicated that students were often permitted to carry on special interest projects when assigned work was finished; 48 per cent did this occasionally and 8 per cent rarely did this. The implications were that 8 per cent of the respondents did not allow for the broaden of the students' scientific horizon.

Thirty-two per cent of the respondents indicated that they often encouraged their students to participate in after school or Saturday school sponsored science activities; ten or 40 per cent occasionally did this. Fifteen or 60 per cent of the respondents indicated that they very often encouraged science students to join science clubs; eight or 32 per cent occasionally did so and 8 per cent rarely or never encouraged students to join science clubs.

TABLE 44

DIFFERENTIATED TEACHER-STUDENT ACTIVITIES

Item	Number of Responses	Percentage
Provisions for children with special aptitudes and interests in science		
Give more responsibilities in connection with regular science lessons:		
Very often	16	64
Occasionally	8	32
Unknown	1	4
Give special assignments:		
Very often	10	40
Occasionally	13	52
Unknown	2	8
Assign science projects:		
Very often	4	16
Occasionally	17	68
Rarely or never	4	16
Encourage students to peform demonstrations and experiments before class:		
Very often	9	36
Occasionally	13	52
Rarely or never	1	4
Permit experiment after assigned work is complete:		
Very Often	11	44
Occasionally	12	48
Rarely or never	2	8

TABLE 44--Continued

Item	Number of Responses	Percentage
Encourage students to participate in after school and Saturday school sponsored activities:		
Very often	8	32
Occasionally	10	40
Rarely or never	6	24
Unknown	1	4
Invite students to join science clubs:		
Very often	15	60
Occasionally	8	32
Rarely or never	2	8

CHAPTER III

FINDINGS, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Rationale

There has never been greater national concern about the improvements of science teaching as there is today. Evidence that the teacher is the key to an effective science program has prompted science educators to examine the quality of the teaching-learning process in the science education program of secondary schools.

Effective science teaching is the result of planning and persistent, well-directed efforts--not a result of chance. The most effective learning occurs from situations in which the learner is actively engaged. This active engagement includes the learner's understanding and acceptance of the purpose to be fulfilled.

An education that will enable young people to live intelligently in the world in which they have to live is prevalent. What is taught must have value beyond the context in which it is learned. Learning in every course must be durable, counting for the rest of the student's life. Since much of what is educationally worthwhile had not been announced or discovered, students must be provided with an entrance into knowledge. This is to say that young people should be equipped for life-long learning and in a way that they can travel upon their own--an education that is geared to change and which trains for intellectual self-direction.

A primary objective of science education is to provide enough understanding of the place of science in society to enable the great majority that will not be actively engaged in scientific pursuits to collaborate intelligently with those who are and to be able to appreciate or criticize the effects of science on society. Science education must also provide a practical understanding of scientific methods, sufficient to be applicable to the problems which the citizen has to face in his individual and social life.

During the past few years, some outward signs have appeared which indicate that an improvement in quality of high school science education programs is taking place. Curriculum reorganization has shown unmistakably quickening tempo. One well-publicized effort has produced the Physical Science Study Committee's physics (PSSC). The American Institute of Biological Sciences recently started investigation which led ultimately to new high school biology courses (BSCS) a corresponding study has been completed in chemistry (Chem Study and Chemical Bond). Complete courses in physics and chemistry have been filmed and are available to high schools wishing to use them. A course in classical and modern physics has been televised. The first similar course in chemistry was presented during the 1959-60 school year. The use of "open-ended" experiments and semi-micro laboratory techniques in chemistry is expanding. In the past three years, many of the basic sciences have appeared in the programmed form: this form of learning has been quite popular among pre-college students. Advanced courses in science and science seminars are appearing in the curriculum of high schools. An increasing number of high school science teachers are participating in expanded in-service and institute programs designed for improvement of subject-matter competency.

Evolution of the Problem

The writer became interested in the impact of effective science teaching and its relationship to academic success while in college. The observation of the many teaching methods after he began to teach, some effective and others ineffective, interested the writer to the extent of reviewing reports, attending conferences and holding group discussions concerning effective science teaching. It was amazing to find that many fellow teachers of science found their teaching ineffective. This prompted the writer to do this study, with the belief that an increased knowledge of the factors involved in effective science teaching would enable him and other fellow science teachers to understand why some are effective while others are not.

Contribution to Educational Knowledge

This study was designed to reveal the professional qualifications of selected individuals teaching science in the Atlanta and Fulton County area. Similar studies might be used to ascertain the factors of effectiveness existing in any given system. It might also indicate the effect of extra-curricular activities within or without the school, directly or indirectly, upon the teacher's effectiveness in the teaching of science. The study might provide a general picture of the physical condition affecting science teaching.

Finally, the important information which the study revealed might be useful to administrators, supervisors, and teachers regarding their thoughts of strengthening and vitalizing the periodic in-service program existing in the locale studied.

Statement of the Problem

The problem of this study was to apply and evaluate "factors of effectiveness" in the existing programs of science education in certain Atlanta and Fulton County public secondary schools.

Purpose of the Study

The major purpose of this study was to ascertain the extent of effective or ineffective science teaching in selected Atlanta and Fulton County public secondary schools. The specific purpose of this study was to answer the following questions:

1. To what extent were "factors of effectiveness" present, or otherwise neglected in the teaching of secondary school science in the schools studied?

2. What evidence existed that "factors of effectiveness" as applied to these teachers, were actually related to the overall effectiveness of these teachers?

3. What steps might be taken to increase the effectiveness of science teaching in public secondary schools of the Atlanta and Fulton County area?

Procedual Steps

The following procedual steps were executed in order to achieve the purpose of this study.

1. A review of related literature was made.

2. Permission to conduct this study was secured from the proper authorities.

3. The questionnaires were sent to the selected persons in each school.

4. The data derived from the questionnaire and check sheet was tabulated and presented in appropriate figures and tables.

5. The data was analyzed and interpreted in terms of the factors of effectiveness formulated by Warren M. Davis.

6. The statements of findings, conclusions, implications, and recommendations derived from the analysis and interpretation of the data was formulated in the finished thesis copy.

Description of Instrument

The instruments used in this study were derived from those formulated by W. M. Davis.[1] When necessary, his instruments were slightly changed to meet the purpose of this study and to be applied to this unique locale.

Davis utilized the method of expert opinion in developing the "factors of effectiveness." The factors were derived from his comprehensive and exhaustive survey of literature, and submission of the derived factors to a jury of experts consisting of: (a) the entire member of the National Association for Research in Science Teaching Association; (b) a sampling of the membership of the American Association of School Administration and National Association of Secondary School Principals. The seventeen factors eventuated are as follows:

1. Others factors being equal, effective learning is more likely to occur when the teacher has a broad background

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[1]Warren Maywood Davis, "Factors of Effectiveness in Science Teaching and Their Application to the Teaching of Science in Ohio's Public Secondary Schools," (unpublished Doctoral dissertation, University of Ohio, 1952).

of knowledge in the particular science he is teaching as well as the related scientific areas.

2. Other factors being equal, effective learning is more likely to occur when the teacher has a functional knowledge of how children develop and how learning takes place.

3. Other factors being equal, effective learning is more likely to occur when the teacher knows about and uses a variety of methods of instruction as opposed to the exclusive use of one or two methods.

4. Other factors being equal, effective learning is more likely to occur when the teacher is living the life of a normal citizen in the community, exerting community leadership appropriate to this educational position.

5. Other factors being equal, effective learning is more likely to occur in our society when the teacher has well-thought-out and consistent philosophy and when the teaching practices are consistent with the stated philosophy.

6. Other factors being equal, learning will proceed more effectively when the teacher is skilled in the use of classroom aids and devices, when he is familiar with, has accumulated, and uses teaching materials of various kind and when he knows about and uses sources of information beyond the singular textbook.

7. Other factors being equal, learning will proceed more effectively when the major professional interest of the teacher and his major expenditures of time and energy are concerned with teaching and not with some other occupation.

8. Other factors being equal, learning will proceed more effectively when the teacher has established rapport with the learners and when the learners believe that the teacher is well informed and effective.

9. Other factors being equal, learning will be more effectively when there is mutual respect between the science teacher and his immediate supervisor.

10. Other factors being equal, learning will be more effective if the teacher is not carrying an excessive load, either by reason of an excessive number of pupils per day, or an excessive extra-curricular or out-of-school series of responsibilities.

11. Other factors being equal, learning will be more effective in a school which has a wide variety of science offerings than one of which has a very limited number of such offerings.

12. Other factors being equal, more effective learning is more likely to occur when the program in the school is directed toward providing for the special needs of youth of the community rather than when the program is not so directed.

13. Others factors being equal, more effective learning is more likely to occur when the program of the school is directed toward providing the general educational needs of youths than when the program is not so directed.

14. Others factors being equal, learning is more likely to occur when the learner and the teacher sense the direction of the teaching, when both participate in the planning and when they see the fulfillment of their own aims implicit in the objective of the course.

15. Other factors being equal, learning is more likely to occur when the amount and type of laboratory equipments needed to fulfill the aims of the work is present and in operating condition, and if the number and type of aids, devices, supplies, and materials are at hand and in condition for use.

16. Other factors being equal, learning will proceed more effectively in a good physical environment than a poor one.

17. Other factors being equal, effective learning is more likely to occur when considerable attention is given the problem solving, development of critical thinking and scientific attitudes.

Limitation of the Study

This study was limited to the field of science teaching of selected public secondary schools of Atlanta and Fulton County. The study was further limited to a selected group of teachers of science and schools recommended and selected by the writer and his adviser. It is limited by utilization of those "factor of effectiveness" which are felt to be valid in a democratic society. Lastly, the study is limited by reliance upon "factors of effectiveness" for identification of teaching effectiveness.

Definition of Terms

For the purpose of this study, the following terms are defined:

1. "Secondary school" refers to an educational organization under one principal or head teacher, including any combination of grades from eight through twelve.

2. "Factors of effectiveness" refers to the basic set of seventeen factors derived by Warren Maywood Davis as they apply and appear to be importantly consistent with the ends of teaching in a democratic society.

3. "Converted science teacher" refers to a teacher having concentrated in a field other science, but attempts to teach science.

Method of Research

The method of research employed in this study is the "Descriptive-Survey Method." Descriptive materials were gathered by use of questionnaires and checklist to obtain data pertinent to the study.

Locales and Period of the Study

This was conducted during the academic year 1964-65 inclusive of the summer of 1965. The material was sent to twenty-five teachers of science in selected secondary schools of Atlanta and Fulton County.

Description of Subjects

The subjects involved in this study were twenty-five secondary science teachers of the Atlanta and Fulton County area.

Survey of Related Literature

A review of related literature brings to focus many points of view from eminent students and educators in the field of education. Many educators are deeply interested in the effectiveness of secondary science teahcers' preparation, background, selection, and other contributing factors toward an effective and successful educational program, and thus make contributing points of view to this study. An effort was made to determine the extensiveness of the pertinent literature concerning the following topics:

1. Studies dealing with philosophies and objectives of science education
2. Studies dealing with the status of science education
3. Studies dealing with science offerings in secondary schools
4. Studies dealing with teaching and competence
5. Studies dealing with preparation of science teachers
6. Studies dealing with problems encountered by secondary science teachers
7. Studies dealing with
8. Studies dealing with community resources

Philosophy and Objectives.--The development of desirable, meaningful modern philosophies and objectives present a colossal task for science teachers. This development and execution require persons of exceptional qualifications character and academic and professional preparations.

Analysis of statements by Dewey,[1] Bernal,[2] and Weaver[3] and the National Society for the Study of Education[4] revealed a concensus of opinion regarding the essential principles of a modern science education program in a democratic society. Edel[5] and Ragan[6] gave more flexibility to the philosophical outlook of modern teachers of science.

The committee for the Forty-six Yearbook[7] stated in formulating objectives, it should be practical and usable for the classroom teacher, should be psychologically sound, should be possible to attainment under reasonably favorable circumstances and to a measurable degree, should be universal in a democratic society and the statement of objectives

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[1]John Dewey, "Methods in Science Teacher," Science Education, XXIX, No. 3 (April, 1945), pp. 119-120.

[2]J. D. Bernal, "Science Teaching in General Education," Science and Society, IV, No. 1 (Winter, 1940), p. 2.

[3]E. K. Weaver, "A Philosophy for a Sound Education Program," Education, LXX (September, 1950), pp. 350-351.

[4]Nelson B. Henry (ed.), "Science Education in American Schools," Forty-six Yearbook of the National Society for the Study of Education, Part I (Chicago, Illinois, University of Chicago Press, 1946), p. 39.

[5]Abraham Edel, Theory and Practice of Philosophy (New York: Harcourt, Brace, & Co., 1946), p. 5.

[6]William B. Ragan and Celia Burns Stendler, Modern Elementary Curriculum (2nd ed. rev., New York: Holt, Rinehart and Winston, 1961), p. 88.

[7]Henry, loc. cit.

should indicate the relationship of classroom activity to desired change inhhuman behavior. Science teachers must realize that the objectives for the science program should be determined by the need of the particular society in which the objective is being formulated.

The status of science education.--The status study in science education by Johnson[1] in 1948-49, Martin[2] in 1952 and recently the United States Office of Education as reported by Obourn[3] shows a growing concern for the type of science education being taught in our modern schools. Richardson,[4] the Educational Policies Commission,[5] the Commission on Secondary School Curriculum[6] and the Miami Workshop Committee[7] are in consonance in their belief that the purpose of the general education is to meet the needs of individuals as to promote the fullest possible realization of personal potentialities and the most effective participation in a democratic society.

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[1]Phillip G. Johnson, "The Teaching of Science in Public High Schools," Office of Education Bulletin, No. 9, 1950.

[2]Edger Martin, "The Teaching of General Bilogogy in the Public High School of U. S.," Office of Education Bulletin, No. 9, 1950.

[3]Ellsworth S. Obourn, "Survey and Status Study," Science Education, XLV, No. 5 (December, 1961), pp. 391-393.

[4]John S. Richardson, Science Teaching in Secondary Schools (Eglewood Cliffs,New Jersey: Prentice-Hall, 1959), p. 34.

[5]Education Policies Commission, "Education for All American Youth," NEA Journal (Washington, D. C.; 1944).

[6]Commission of Secondary School Curriculum Progress Education Association, Science in General Education (New York: Appleton Century Crafts, Inc., 1938).

[7]Miami Workshop Committe, Working Together for Ohio's Schools (Kent, Ohio: College of Education, Kent State University, Second Miami Workshop).

Crowder[1] found that teachers felt that they were in a sense second class members of the community, fooling themselves and restricted often at the expense of their creativity. However, Mead[2] and Kaplan[3] found that the situation described by Crowder has been somewhat changed. Anderson recommended that "teacher should engage in other work experiences on a voluntary basis, other than teaching in order that they may gain a better understanding of the community and its economic life."[4]

Science offerings in secondary schools.--Johnson,[5] in a survey of 735 schools, found a number of them offering courses in applied physics, applied chemistry and applied science, which are less rigorous than the academic courses they parellel. Physical science is occasionally offered as a substitute for physics and chemistry. It has made a great contribution to the offerings of secondary schools. Brown[6]

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[1]Fransworth Crowder, "Educational Strait Jackets," Survey Graphic, XXXVI (November, 1947), pp. 617-619.

[2]Margaret Mead, "Teachers Place in American Society," American Association of University Women's Journal, XXI (October, 1946) pp. 3-5.

[3]Louis Kaplan, "New Horizons in Teacher-Community Relationships," Journal of Educational Society, XXI (March, 1948), pp. 417-427.

[4]Stuart Anderson, "A Study of the Professional Personnel of Wisconsin Schools with Special Reference to Extra-Contractual Income," Journal of Experimental Education, VIII (September, 1948), pp. 92-200.

[5]Johnson, op. cit., No. 5.

[6]Kenneth E. Brown, Offerings and Enrollment in Science and Mathematics in Public High Schools, U. S. Department of Education, No. 120 (Washington, D. C.: U. S. Government Printing Office, 1957).

reported that 715 schools or 19 per cent reported additional or alternate science courses and the number of offering are still increasing.

Teaching effectiveness and competence.--Cunningham[1] and Taylor[2] agree that there doesn't seem to be any best method of teaching science. Washton[3] implies that we must try various methods until we find an adequate one for that particular teaching situation.

Havighurst[4] and Charters[5] agree that a knowledge of the students' human growth and development is essential in science teaching. Street[6] felt that competencies cannot be described in terms of lists of desirable teacher traits. He felt that these traits are meaningless unless they become a part of an individual's pattern of behavior.

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[1]Harry A. Cunningham, "Lecture-Demonstration Versus Individual Laboratory Method in Science Teaching--A Summary," Science Education, XXX (March, 1964), pp. 70-82.

[2]Harold O. Taylor, "A Comparison of the Effectiveness of a Lecture Method and a Small Group Discussion Method of Teaching High School Biology," Science Education, XLIV (December, 1959), pp. 442-446.

[3]Nathan S. Washton, Science Teaching in Secondary Schools (New York: Harper, 1961), p. 14.

[4]Robert J. Havighurst, Developmental Tasks and Education (New York: Lognmans-Green, 1950), pp. 4-6.

[5]W. W. Charters, Jr., "Human Relation in Education," Review of Educational Research, XXIX (October, 1959), pp. 313-390.

[6]Calvin M. Street, "The Development of a Competent Pattern with Application to the Area of Industrial Arts Education" (unpublished Doctorial dissertation, University of Tennessee, 1953).

Johnson[1] and Ingram[2] felt that if a teacher fails or is incompetent because he does not know how to conduct a class, the teacher-training institution must bear much of the blame. Conversely, if the lack of the abilities cause failure of the teacher, it may be safe to assume that their possession in higher degree would render a more competent and effective teachers.

Preparation of science teachers.--The AAAS Cooperative Committee[3] stated that the preparation of the teacher previous to entering his profession, should be sure that he meets the general recommended preparation for certification. MacCurdy[4] and Bryant[5] seem to be in consonance that a knowledge of educational psychology and human growth and development is essential in teacher training.

Facilities and equipment.--Before the National Defense Education Act was signed in 1958, Charles Koelsche[6] reported that the overall

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[1]Robert S. Johnson, "Factors of Effectiveness in Science Teaching in Georgia Public Secondary Schools Accrediated by the Southern Association of Colleges and Secondary Schools" (unpublished Master's thesis, School of Education, Atlanta University, 1960).

[2]Silas Ingram, "Factors of Effectiveness in Science Teaching in Certain of the Richmond County Public Schools" (unpublished Master's thesis, School of Education, Atlanta University, 1963).

[3]The AAAS Cooperative Committee on the Teaching of Science and Mathematics, "Recommendations for the Training of Science Teachers," School Science and Mathematics, CXXXI, No. 3406 (April 8, 1960).

[4]Robert D. MacCurdy, "Call Him Teacher," Science Education, LXIX, No. 1 (February, 1963), p. 28.

[5]Vera R. Bryant, "The Effectiveness of Science Teaching in Certain Atlanta Public Elementary Schools" (unpublished Master's thesis, School of Education, Atlanta University, 1958), p. 38.

[6]Charles L. Koelsche and John S. Richardson, "Facilities and Equipment Available for Teaching Science in Public High School, 1958-59," Research Foundation, University of Tolddo, 1960, pp. 27-33.

rating of science equipment showed that chemistry equipment was judged best, general science second, biology third, and physics poorest.

According to Thomas Francis[1] improvements in the science program is brought about by the new involvement of highly specialized equipment. Nelson[2] and Kelly thought that a teacher not using audio-visual materials is working much harder than those using this equipment and accomplishing proportionately more. However, Todd[3] warns us not to forget that the teacher is the most essential item of equipment. The best facilities are to no avail in the absence of a dynamic and creative teacher.

<u>Community resources</u>.--Effective use of community resources require that the teacher survey and evaluate the local community listing the resources that contribute most to an understanding of the specific science area under study. Thurber[4] contentions are that there are surperb teaching situations around most schools. These facilities are means to desirable ends and should not be neglected.

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[1]Thomas Francis, "Summary of Current Science Improvements," <u>Science Newsletter</u>, XXXVI (July, 1963), p. 21

[2]Pearl A. Nelson and Gaylen B. Kelly, "Some Common Problems in the Use of Audio-Visual Materials," <u>Science Education</u>, XLVIII, No. 1 (February, 1964), p. 37.

[3]Charles H. Todd, "The Teacher," <u>Phi Delta Kappan Bulletin</u>, XXII (Chicago, 1960), p. 78.

[4]Walter A. Thurber, <u>Teaching Science in Today's Secondary Schools</u> (Boston: Allyn and Bacon, 1959), p. 390.

Problems encountered by science teachers.--The task that confronts a teacher is one of high complexity and carries with it the deepest obligation. This complexity perpetrates many problems some of which are emphasized by Anderson[1] and Koelsche.[2] Some of these problems are: (1) lack of laboratory, (2) lack of time for preparing materials for laboratory and classroom demonstrations, (3) lack of equipment and supplies, (4) too many extra-curricular duties, and (5) too many preparations. The use of "converted" science teacher has created an additional problem in the teaching of science. It has been found that these "converted" science teachers do not use varied and effective instructional practices as often as the qualified science teacher.

Summary and Findings

The basic findings of this research are summarized and presented in statements and tables under the following headings:

1. Respondents Reactions to the Seventeen Factors of Effectiveness
2. Rank Order of Factors Receiving Acceptance
3. Data on Personal Characteristics of the Respondents
4. Data on Professional Characteristics of the Respondents
5. Data Pertaining to Methods and Materials of Instruction
6. Data Pertaining to Facilities and Equipment
7. Data on Provisions for Students with Special Aptitudes and Interest in Science.

TABLE 18

SUMMARY DATA ON THE TWENTY FIVE SECONDARY SCIENCE TEACHERS' REACTIONS TO THE SEVENTEEN FACTORS OF EFFECTIVENESS

No.	Criteria Factors of Effectiveness	Agree		Qualified Agreement		Disagree		Qualified Disagreement	
		No.	%	No.	%	No.	%	No.	%
1	Backgroung Knowledge in Science and Related Fields	24	96	1	4	0	0	0	0
2	Functional Knowledge of Human Growth and Development	24	96	1	4	0	0	0	0
3	Knowledge of Method of Instruction	22	88	2	4	0	0	1	4
4	Philosophy of Teaching	17	68	2	8	4	16	2	8
5	Citizenship and Leadership in the Community	22	88	2	8	0	0	1	4
6	Skill in Use of Classroom Aids and Devices	25	100	0	0	0	0	0	0
7	Teacher-Pupil Rapport	24	96	1	4	0	0	0	0
8	Extra-Contractual Occupation	21	84	2	8	1	4	1	4

TABLE 18--Continued

No.	Criteria Factors of Effectiveness	Agree		Qualified Agreement		Disagree		Qualified Disagreement	
		No.	%	No.	%	No.	%	No.	%
9	Teacher-Supervisor Rapport	20	80	2	8	2	8	1	4
10	Excessive Responsibilities	25	100	0	0	0	0	0	0
11	Science Curriculum of the School	20	80	3	12	1	4	1	4
12	Special Skills of the Youth in the Community	21	84	1	4	1	4	2	8
13	General Educational Needs of the Youth	17	68	3	12	4	16	1	4
14	Objectives of the Science Course	21	84	3	12	0	0	1	4
15	Laboratory Equipment	23	92	2	8	0	0	0	0
16	Physical Environment of the School	25	100	0	0	0	0	0	0
17	Scientific Attitude	21	84	2	8	0	0	2	8

TABLE 19

SUMMARY DATA ON THE NUMBER AND RANK OF ACCEPTANCE OF THE CRITERIA SEVENTEEN FACTORS OF EFFECTIVENESS IN SCIENCE TEACHING INDICATED BY THE TWENTY-FIVE SECONDARY SCIENCE TEACHERS OF ATLANTA AND FULTON COUNTY

Factors	No. Accepting	Rank
1 - Background in Science and Related Fields	24	2
2 - Functional Knowledge of Human Growth and Development	24	2
3 - Knowledge of Methods of Instruction	22	4
4 - Philosophy of Teaching	17	7
5 - Citizenship and Leadership in the Community	22	4
6 - Skill in Use of Classroom Aids and Devices	25	1
7 - Teacher-Pupil Rapport	24	2
8 - Extra-Contractual Occupation	21	5
9 - Teacher-Supervisor Rapport	20	6
10 - Excessive Responsibilities	25	1
11 - Science Curriculum of the School	20	6
12 - Special Skills of the Youth of the Community	21	5
13 - General Educational Needsof Youth	18	7
14 - Objective of the Science Course	21	5
15 - Laboratory Equipment	23	3

Data on personal characteristics of respondents.--

1. Fifty-five per cent were males and 44 per cent were females.

2. Thirty-six per cent of the respondents held other positions prior to teaching.

3. Eighty per cent of the respondents had less than ten years of teaching experience in Atlanta and Fulton County.

4. Forty-eight per cent held degrees beyond the bachelor degree.

5. The respondents attended eleven colleges in four states.

6. Sixty per cent participated in no community organizations.

7. Fifty-six per cent of the respondents did not engage in leadership roles in church organizations.

8. Forty-eight per cent of the respondents were members of some fraternity or sorority.

9. Sixty per cent of the respondents are members of the NSTA.

10. Sixty-four per cent of the respondents had done nothing that was of value to them in the teaching of science that did not appear on their transcript.

11. Twenty per cent of the respondents did not read any science or scientific magazines regularly.

12. Eighty per cent of the respondents took part as leaders in movements for the common good of the community and 96 per cent thought that the community allowed them to lead normal lives.

13. Thirty-six per cent of the respondents did not participate in community drives.

14. Forty-eight per cent of the respondents thought that some extra-curricular activities are harmful to the science teaching program.

15. Fifty-two per cent of the respondents taught in schools with enrollments of 1,200 or more.

Data on professional characteristics of the respondents.--

16. Fifty-six per cent of the respondents had 1-4 years of teaching experience in Atlanta and Fulton County.

17. Fifty-two per cent of the respondents had less than ten years total of teaching experience.

18. Forty-eight per cent of the respondents graduated between 1950-59.

19. Forty per cent of the respondents held DT-5 (life professional secondary) certificates.

20. All of the respondents were certified to teach science in secondary school.

21. Forty-four per cent of the respondents taught in biology as their major teaching assignment and 24 per cent taught chemistry.

22. Fifty-two per cent of the respondents taught in classes that contained thirty or more students.

23. Thirty-two per cent of the respondents had 21-26 credit hours in professional education.

24. Sixty-eight per cent of the respondents had biology as their undergraduate field of concentration, 40 per cent had chemistry, and 20 per cent had physics as their undergraduate major.

25. Thirty-six of the respondents had chemistry as an undergraduate minor.

26. Ninety-two per cent of the respondents had done graduate work.

27. Seventy-two per cent of the respondents attended Atlanta University graduate school.

28. Twenty-five per cent of the respondents had done post graduate work.

29. Twenty per cent of the respondents had had 24 or more semester credit hours in chemistry.

30. Five or 20 per cent of the respondents had earned twenty-four or more semester hours credit in zoology and 20 per cent of the respondents had had courses in physics.

31. Sixty-four per cent of the respondents had no other occupation than teaching.

32. Thirty-six per cent of the respondents prepared two preparations daily.

Data pertaining to methods and materials of instruction.--

33. Sixty-four per cent of the respondents used movies frequently.

34. Ninety-six per cent of the respondents used filmstrips frequently.

35. Eighty per cent of the respondents used recordings and transcribing devices.

36. Eighty-eight per cent of the respondents felt thoroughly competent to work with normal laboratory demonstration apparatus.

37. Eighty per cent of the respondents used models, and live exhibits frequently.

38. Ninety-two per cent of the respondents stated that they used resource units, however, only 48 per cent were using them at the time of this study.

39. Sixty-eight per cent of the respondents indicated that they frequently allow students to help in the planning of their work.

40. Forty-eight per cent of the respondents followed the direction of a particular textbook.

41. Eighty-four per cent of the respondents occasionally gave tests of their own construction.

42. Ninety-six per cent of the respondents were familiar with two sources of printed tests.

43. Sixty-eight per cent of the respondents occasionally made use of the community for learning experiences outside the classroom.

44. Seventy-two per cent of the respondents were familiar with the resources from the museum, State Department of Agriculture, etc.

45. Ninety-two per cent of the respondents were familiar with the Science Club of America but only 24 per cent used their free or low cost materials frequently.

46. Sixty-eight per cent of the respondents were familiar with the Junior Academy of Science.

47. Sixty-eight per cent of the respondents did not know how much money per child had been allocated for purchasing materials and supplies for the teaching of science.

48. Eighty-eight per cent of the respondents had supervisory help in teaching science.

49. Thirty-six per cent of the respondents felt that the materials and supplies were adequate for teaching science.

50. Fifty-two per cent of the respondents consulted the state guide very often, 60 per cent consulted the school guide very often and 84 per cent of the respondents used their own ideas in formulating their lesson plans.

Data pertaining to facilities and equipment.--

51. Seventy-two per cent of the respondents thought that their physical environments were good.

52. Eighty per cent of the respondents indicated that their laboratory furniture was in good condition.

53. Seventy-six per cent of the respondents indicated that their rooms were properly painted.

54. Forty-four per cent of the respondents indicated that their ventilation and heating systems were excellent.

55. Seventy-six per cent of the respondents indicated that their janitoral service was adequate or fairly adequate.

Data or provisions for students with special aptitude and interest in science.--

56. Sixty-four per cent of the respondents indicated that they very often gave considerable responsibilities to special students in connection with the regular class duties.

57. Forty per cent of the respondents gave additional assignments to special students only.

58. Sixty- eight per cent of the respondents indicated that their students were occasionally assigned science projects not designed for the entire class.

59. Thirty-six per cent of the respondents indicated that special students very often perform demonstrations or experiments before classmates.

60. Forty-four per cent of the respondents indicated that special students were allowed to carry on special interest projects when assigned work was finished.

61. Sixty per cent of the respondents indicated that they very often encouraged students to join the science club.

Conclusions

The analysis of the data gathered and presented in this study has made the following conclusions possible:

1. The percentage of agreement of the "factors of effectiveness" by the respondents seem to be indicative of an over-all effective science teaching program in the Atlanta and Fulton County public secondary school system.

2. The respondents indicated a ralization of the importance of well-thought-out and consistent philosophy and consistency of the teaching practices with this philosophy.

3. The lack of materials and equipment was not found to be a major problem among the schools studied.

4. A major problem which was found to exist in the locale studied was that of overcrowded classes and too many classes. This overcrowdedness prevents the individual attention needed for students in secondary science courses and excessive classes prevents ample preparation for any single class.

5. The lack of facilities and quipment posed no serious problem to the respondents.

6. Too few science teachers make use of free and low cost materials, however, most of them are aware of their existence.

7. Science teachers have too many extra-curricular duties which affect the efficiency of the science teaching program.

8. The importance of continous study to insure knowledge of modern science teaching procedures is definitely realized in the Atlanta and Fulton County area.

9. Too few science teachers participate in community drives and organizations.

10. More science teachers should participate in in-service programs.

11. Some science teachers need more professional education courses.

12. The majority of the teachers did not know how much money per pupil was allowed for purchasing materials and supplies for the teaching of science.

13. Too few science teachers engage in science related activieies.

14. Too many teachers do not teach in their major field of concentration.

15. The science teachers are not associated in a strong local organization.

Implications

The implicationsfor theory and practice which grow out of this study are characterized below:

1. There is a need to evaluate the overcrowdedness and excessive classes in secondary science classrooms.

2. There is need for an annual publication of free and low cost materials by the State Department of Education and sent to the secondary schools over the state.

3. There is need for colleges and departments of education to to make careful study and improve the professional education courses and the content courses designed for science teachers.

4. There is need for a stronger relationship between science teachers and the people of the communities in which they teach.

5. There is a need for science teachers to engage in more science related activities.

6. There is a need for the realization by the principal of the importance of placing teachers in positions of their major area of preparation so that their teaching ability can be used to a maximum.

7. There is need for an organization for science teachers of the locale studied.

8. There is need for a comprehensive and intensive program of in-service training, with emphases upon the new approaches in content, sequence and metholology.

Recommendations

It is felt that the findings of this research warrant the following recommendations for the increased effectiveness of science teaching in certain Atlanta and Fulton County secondary schools.

1. There should be no more than twenty-five students in any given science class.

2. The State Department of Education should send annual publications of free and low cost materials to secondary schools over the state.

3. Colleges and departments of education should make a careful study of and improve the professional educational courses and the content courses designed for science teachers.

4. There should be a stronger relationship between science teachers and the people of the communities in which they teach.

5. Teachers should engage in more science related activities.

6. Principals and superintendents should place teachers in their major fields of preparation.

7. The teachers of Atlanta and Fulton County schools should form one strong science organization.

8. The local colleges and universities should initiate a comprehensive and intensive program of in-service training.

Recommendations for Further Study

1. School administrators should act more vigorously in finding ways to relieve the classroom teacher of nonprofessional duties, and in establishing reasonable work loads which will attract intelligent young people.

2. A way should be found to carry out a substantial research project related to the identification and development of the master science teacher.

3. A study should be made on acquisition of special consultants provided by the state and the local school boards to create competence among science teachers.

4. A study should be made on resource persons, with an adequate background in science and some released time from teaching to enable them to be available for on-the-job assistance to beginning teachers.

5. Special training for secondary school science teachers should be developed in pre-service and in-service programs.

6. Further studies should be made on resolution of the problem of the establishment of rapport and mutual respect between supervisor and teacher as important factor affecting the effectiveness of the teaching.

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APPENDIX

Specimen of Questionnaire--Criteria Seventeen Factors of Effectiveness of Teaching Science as dervied by Warren M. Davis.

Fellow Science Teacher:

As a portion of my Master's study at Atlanta University, I wish to validate certain characteristics of an effective learning situation in the area of secondary science. In order to approach this problem, statements have been chosen which describe conditions which may or may not bear on the effectiveness of the learning situation.

In each cause, there is given an opportunity to indicate whether you agree or disagree with the statement as it stands, also to indicate any qualification you may wish to make additionally. Space has been provided at the end of the paper in order that you may add further statements which you believe have not been included. You may, if you wish, use this space for making general comments.

Please note that no attempt has been made to include all of the characteristics of an effective learning situation. However, if you feel that very important characteristics worthy of study have been omitted, you are invited to add them to the listings.

It is hoped that you will be able to complete this short form within a few days and to return it in the enclosed stamped envelope. If you include pertinent comments, it is requested that you sign the form, since such comments may require a later exchange of correspondence.

Thank you for your assistance.

Sincerely yours,

Calvin F. Turner

Calvin F. Turner

FACTORS RELATED TO THE EFFECTIVENESS OF A LEARNING SITUATION IN SECONDARY SCIENCE

The following characteristics have been ascribed to an effective learning situation in secondary science. You may or may not agree with any or all of these characteristics. On the other hand you may agree with a characteristic with certain qualifications to your agreement. Note that there is one qualification present in each statement, namely: Other factors being equal. This qualification should be taken into account throughout.

There is no thought that this list of characteristics describes completely an effective learning situation, rather it merely constitutes what is believed to be a partial list which may serve as the basis for a study.

It is requested that you make a note of your agreement or disagreement by circling the appropriate word, or that you make your use of the space provided for qualifying your answer. Space has been provided at the end for addition or other pertinent points, or for your comment. It is hoped that you will be able to complete this form and return it in the enclosed stamped envelope. Thank you.

1. Other factors being equal, effective learning is more likely to occur when the teacher has a broad background of knowledge in the particular science he is teaching as well as in the related scientific areas. (Agree Disagree)

Qualifications: ____________________

2. Other factors being equal, effective--learning is more likely to occur when the teacher has a functional knowledge of how children develop and how learning takes place. (Agree Disagree)

Qualifications: ____________________

3. Other factors being equal, effective--learning is more likely to occur if the teacher knows about and uses a variety of methods of instruction as opposed to the exclusive use of one or two methods. (Agree Disagree)

Qualifications: ____________________

4. Other factors being equal, effective--learning is more likely to occur when the teacher is living the life of a normal citizen in the community, exerting community leadership appropriate to his educational positions. (Agree Disagree)

Qualification: ____________________

5. Other factors being equal, effective--learning is more likely to occur in our society when the teacher has well-through-out and consistent philosophy and when the teaching practices is consistent with the stated philosophy. (Agree Disagree)

Qualification: ____________________

6. Other factors being equal, learning will proceed more effectively when the teacher is skilled in the use of classroom aids and devices, when he is familiar with, has accumulated, and uses teaching materials of various kinds, and when he knows about and uses sources of information beyond the singular textbook. (Agree Disagree)

Qualification: ____________________

7. Other factors being equal, learning will proceed more effectively when the teacher has established rapport with the learners and when the learners believe that the teacher is well informed and effective. (Agree Disagree)

Qualification: ____________________

Form A
Professional Training

1. Name of School ____________________ City ____________________
   Size of School __________.
2. Grades included _______________ Years in present position ______.
3. Other systems in Georgia ___________ Other systems outside of Georgia, but in the continental U. S. ______________ Where? _______ ____.
4. Outside the continental U. S. _______________ Where? ____________.
5. Total years of experience ___________. Age ____________.
6. Area of major Teaching ______________. No. in class ____________.
7. Area of minor Teaching ______________. No. in class ____________.
8. Further Areas of teaching ____________. No. of daily preparations ___________.
9. Highest degree held, institution and year in which received?

Degree	Institution	Year
a. A.B.		
b. B.S.		
c. M.A.		
d. M.S.		
e. Ph.D.		
f. Ed.D.		

10. If your highest degree is the bachelor's degree, have you done graduate work? Yes _____. No _____. Where? ______________________ How many semester hours were earned? ___________.
11. If your highest degree is the master's degree, have you done post graduate work? (post master's degree) Yes _____. No ________. Where? __ _____________________. How many semester hours were earned? ________.
12. How many undergraduate semester hours did you earn in professional education? ___________.
13. How many graduate semester hours did you earn in professional education? ____________.
14. What kind of teaching certificate do you hold at the present? ________ ____________________.
15. What subjects are you entitled to teach according to your certificate? ______________________________________.
16. How many semester hours do you have in each of the following areas?

   a. Physics ___________ g. Physiology & Health Science _______
   b. Chemistry _________ h. Geography ____________
   c. Botany ___________ i. Geology ____________
   d. Zoology __________ j. Gen. Science __________
   e. Bacteriology_______ k. Meterology ____________
   f. Astronomy _________ l. Others (specify) ______________

17. Science courses offered by the High School: (check)

   a. Biology (Gen.) ______ e. Physics ______
   b. Human Biology ______ f. Geography ______
   c. Chemistry ______ g. Physiology _____
   d. Gen. Science ______ h. Earth Science___
   i. Others (specify) ___________

18. Indicate in the proper blank your major subject trained in undergraduate, graduate and post graduate. Note by major is meant the subject of greatest importance on the basis of credits earned. By minor is meant the subjects of next importance on the basis of credit earned.

Subjects	Undergraduate (major)	Undergraduate (minor)	Graduate (major)	Graduate (minor)	Post Graduate (major)	Post Graduate (minor)
a. Agriculture						
b. Biology						
c. Chemistry						
d. Economics						
e. English						
f. Elem. Ed.						
g. Guidance						
h. French						
i. Mathematics						
j. Physics						
k. Others (specify)						

Form C
Methods, Physical, Equipment, Etc.

1. In your teaching do you use movies frequently? ______. occasionally? ______. not at all? ______.
2. Can you operate a 16 mm moving projector of the types commonly found in schools? __________.
3. Can you make minor repairs and adjustments to a moving picture projector? ________.
4. Do you use filmstrips or film slides frequently? ________. occasionally? __________. not at all? __________.
5. Can you operate a filmstrip or film slide projector? ____________.
6. Can you make home-made slides which are appropriate for use in science class? ________. Do you ever make or use such slides? __________.
7. Can you operate a recording and transcribing device of any type? ______ disk, tapes or wire? ________________.
8. Do you use recording and transcriptions frequently? ________. occasionally? __________. not at all? _________ in your teaching.
9. Do you make use of models, like exhibits, dioramas, etc. in your teaching frequently? _______. not at all? ________. occasionally? ______.
10. Do you or members of your class construct models, exhibits, etc. for class use frequently? _______. occasionally? __________. not at all? ___________.
11. If you or members of your classes wish to carry out experiments or demonstrations for which equipment is not available, do you devise (or aid pupils in devising) such equipment frequently? ________. occasionally? __________. not at all? __________.
12. Do you feel competent to work with normal laboratory and demonstration equipment in high school science, thoroughly? _______. partially?______ do not feel competence on handling such equipment? __________.
13. Do you find it advisable to make use of your community for the purpose of taking your science classes outside the classroom frequently? ______. occasionally? ____________. not at all? ___________.
14. If the preceding answer is "not at all" why do you not use such trips? ____.
15. Do you and your students use school or public library materials as sources for finding material for your work in science frequently? ____________ occasionally? ____________. not at all? ___________.
16. Do you make use of one basic textbook or do you use two or more textbooks regularly as sources of information? one_____. two______. more than two___________.
17. Do you use printed or written materials beside from the textbook, laboratory manual, and workbook frequently? ________. occasionally?______. not at all (never go beyond these sources of information?) ___________.
18. Do you bring local materials and community resources (including speakers) into your classes frequently? _______. occasionally? _________. not at all__________.
19. Are you familiar with the resources for science teachers which are available from the State museum and a few other such sources such as the State Department of Agriculture? ______________.
20. Do you use state resources such as those mentioned in the preceding question frequently? ________. occasionally? _______. not at all? _____.
21. Are you familiar with at least two sources of printed texts (Standardized or otherwise) in science? ______________.
22. Do you give tests other than those of your own construction frequently? _________. occasionally? _________. not at all? _________.
23. Do you use in your teaching, or have you used within the past two years, a resource unit, whether of your own construction or obtained from any source what so ever? _________. Am now using. ________. Have used such a unit? ____________.
24. Are you familiar with such listing of free and low cost materials as the Science Club of America Sponsor Handbook, the Peabody Catalogue of Free and Low Cost Materials, or similar listings? ______________.
25. Do you make use of such listings to obtain materilas for your classes frequently? _________. occasionally? ______. not at all?__________.
26. Are you familiar with the work of Science Clubs of America? _________. Do your students make use of materials prepared by this organization?____.
27. Are you familiar with the work of the Junior Academy of Science? _______.
28. Have you had a student to participate in exhibits sponsored by the Local or State Science Fair within the past 2 years? ______________.

Form B
Personal Qualities

1. What type of work have you performed other than teaching which offered valuable experiences as far as the teaching of science is concerned? (Working in Research Laboratory, or steel mill, for example).

   a.
   b.
   c.

2. Over how long a period of time did such experience extend? a.__________ years. b.__________years. c.__________years.
3. What hobbies have you developed which are useful to you in the teaching of science and how long have you had such hobbies?
   a.____________________. a. (years)____________________.
   b.____________________. b. (years)____________________.
4. What school work have you completed which has been useful to you in the teaching of science, but which does not appear on your transcript. (Trade school, for example.)
   ____
5. To what scientific or science teaching association or organization do you belong?____________________.
6. What science or science education magazine do you read regularly?__________ ____________________. Occasionally?____________________.
7. What science or science education books have you read in the past two years (aside from textbook at secondary-school level)?____________________.
8. Please list any other pertinent factors of training which you believe have been of significance to you in your science teaching and which do not appear either in your college transcript or elsewhere in this supplement list of questions.____
   ____.
9. What position of leadership do you hold in church or in any church organization?____.
10. List any out-of-school activities involving youth in which you participate or have recently participated in a position of leadership (such as Boy Scouts, etc.)____.
11. List fraternal, social or service organization which you are a member (Masons, Elks, etc.)____.
12. List any drives or similar community movements which you have taken on outstanding parts in the past two years. (Such as Red Cross, Community Chest, etc.)____.
13. Do teachers in your community usually or often assume positions of leadership in movements for the common good?____________________.
14. Do you believe that your community permit teachers to live a "normal life"? ____________________.
15. List your school responsibilities aside from teaching.
    a. ____________ b.____________ c.____________
    d. ____________ e. ____________ f.____________
16. Do you believe that the amount of time and energy taken by your school responsibilities other than teaching (such as extra-curricular activities) are detrimental to your teaching or that such activities help your teaching? Harmful__________ Helps__________ No difference__________
17. Do you believe that the duties you are expected to do in your community are required because you are a teacher? ________. Do they hurt your efficiency as a teacher?__________. Helps __________. No difference__________.
18. How many hours per week do you spend in some other gainful occupation other than your regular schoolwork? None________. 1-10 hours per week__________. 11-20 hours per week__________. Over 20 hrs. per week__________.
19. List your curriculum load in terms of number of pupils taught and number of preparations per day. Total no. of pupils in class____________________. No. of preparations per day __________. No. of study halls ____________________.

(cont'd)

29. Do you use good publications such as the Bulletins of the U. S. Department of Agriculture or the Bureau of Mines in your teaching, frequently? _____. occasionally? ________. not at all? ________.
30. Do you follow the organization of a particular textbook in developing a plan of teaching for your class? _______. always? _____. usually? ______.
31. Do you plan the teaching solely, or do students often or always help in planning the direction of the work? Teacher plans the work? __________. Both teacher and students plan the work? __________.
32. In your classroom and laboratory do you have, for the most part, the kind and amount of laboratory and demonstration equipment and the materials and supplies needed to fulfill the aims of the course as it is being presented? yes______. almost______. Equipment and/or materials and supplies somewhat inadequate ______. Equipment and/or laboratory supplies totally inadequate __________.
33. In general is the physical environment in your school, particularly in the science department, good? _____. fair? _____. or poor? ________.
34. Is the laboratory furniture in good _____ fair_____ or poor ________ condition?
35. In general are the instruments, devices and materials in your laboratory in condition to use or are many of them in need of extensive repair? In condition to use? _____. Many need repair? ________.
36. Approximately how much money per pupil in your school has been spent in purchasing laboratory equipment and/or supplies during the past two years? (do not include expendable items such as chemicals). _______per pupil.
37. Is your room kept well-painted? _______. fairly well-painted? _______. poorly painted? ______.
38. Do you consider the janitorial service in your science department adequate? __________. fairly adequate? _______. poor? _______.
39. Are ventilation and heating adequate for the greatest degree of pupil comfort and health? __________. If not always, are they usually satisfactory? __________. Seldom satisfactory? __________.
40. Is your science classroom equipped with the proper type of window shades, movie shades, etc. for the best fulfillment of your pupils needs? ______ __________.
41. To what extent are the following resources consulted in your planning?
    a. State guide or course of study: Very often___. Occasionally ______. Rarely or never_______.
    b. Local school guide or course of study: Very often_________. Occasionally_________. Rarely or never________.
    c. Your own ideas: Very often_____. Occasionally? _________. Rarely or never__________.
42. In addition to assistance from the principal, is there other consultants or supervisory help in teaching science available from within your school? Yes_____. No_____. If consultant's help in science is available, to what extent do you make use of it? Very often? _______. Occasionally? _______. Rarely or never _______.
43. To what extent is each of the following provisions made for children with special aptitudes or interest in science:
    a. Give more responsibility in connection with regular science lessons: Very often? ____. Occasionally? _____. Rarely or never? ________.
    b. Give special assignments not required of all children: Very often? ________. Occasionally? _______. Rarely or never? _______.
    c. Assign science projects not related to regular class science program: Very often? _____. Occasionally? _____. Rarely or never? _______.
    d. Encourage students to perform demonstrations or experiments before his classmates: Very often? _____. Occasionally? ____. Rarely or never? ________.
    e. Permit children to do experiments and work with science materials and equipment when they have finished other assignments: Very often? ___ ____. Occasionally? ______. Rarely or never? ________.
    f. Encourage children to participate in after school or Saturday school-sponsored science activities: Very often? _____. Occasionally? _____. Rarely or never? ________.
    g. Invite children to join science clubs: Very often? __________. Occasionally? ________. Rarely or never? ________.
44. In a few words, if you will, please state what you are trying to accomplish in your science teachings. ____________________

Signature (If desired)